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NEW YORK ACADEMY OF SCIENCES.

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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 6th, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the chair.

Twenty-nine persons present.

PROF. W. P. TROWBRIDGE represented the desirability of a Geographic and Geodetic Survey, under the authority of the Government, which should be extended over the whole area of the United States. And a motion was adopted authorizing the Council to consider the preparation of a resolution or memorial, to be presented to the Academy for its action, which should recommend the establishment of such a survey.

PROF. J. J. STEVENSON briefly described his geological work in Southwestern Pennsylvania, and the gypsum and salt deposits at Saltville, W. Va.

Remarks were made upon the physiological effects of carbon di-sulphide by PROF. TROWBRIDGE, PROF. H. C. BOLTON, DR. BRITTON and DR. SCHOENEY.

DR. N. L. BRITTON described his recent visit to the Adirondacks.

MR. B. B. CHAMBERLIN commented on the earthquake recently experienced in New York.

MR. BENJAMIN BRAMAN described the condition of certain glaciers of the Alps which he had visited during the past summer.

MR. GEORGE F. KUNZ remarked upon some Maine minerals and their localities which he had lately visited.

PRESIDENT NEWBERRY gave an account of the Montreal meeting of the British Association for the Advancement of Science, and the Philadelphia meeting of the American Association for the Advancement of Science. He also described his visits to Colorado and Montana.

MR. J. D. WARNER spoke of the water power of the Upper Missouri river.

October 13th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Sixty persons present.

MISS F. R. M. HITCHCOCK exhibited some limestone pebbles from Mt. Lebanon, which were curiously grooved.

DR. J. S. NEWBERRY read a paper entitled,

NOTES ON A RECENT VISIT TO NORTHERN MONTANA; ITS SCENERY, RESOURCES AND GEOLOGICAL STRUCTURE.

(Illustrated with lantern views.)

(Published in the ANNALS Vol. iii., pp. 242-270, under the title, "Notes on the Geology and Botany of the Northern Pacific Railroad.")

October 20th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty-eight persons present.

Sig. Cav. Enrico Nicolis, of Verona, Italy, was elected a Corresponding Member.

Dr. A. A. Julien read a paper entitled,

NOTES ON THE CONSTITUTION OF OCEAN, RIVER AND DESERT SANDS.

(Published in the Proceedings of the American Association for the Advancement of Science, 1884, pp. 413-416.)

Mr. B. B. Chamberlin read the following paper, on

MUSSELS AND MUSSEL CULTURE.

The mussel (*Mytilus edulis*) belongs to a somewhat advanced order of mollusks, possessing lamellar gills, a well-developed stomach, liver and heart, but no distinct head. It has the protection of equivalve shells, situated laterally to the body of the animal.

A remarkable feature of this mollusk is the curious organ termed a "foot." Subsidiary to this is an apparatus termed the "byssus," where a special gland has the power to secrete a supply of silky threads of a viscous nature. These fibres are woven by the foot into a slender cable and fastened by means of the same organ securely to a rock or other foreign object.

The little animal rarely fails to secure itself a good foothold. Should boulders or rocks be wanting, it will make use of pebbles, uniting them in a mass by means of the secreted threads, as shown in the specimen presented for exhibition. Instances are recorded where sea-walls, bridges, etc., have been materially strengthened and preserved by the operations of these little creatures.

The culture of these mollusks is a subject of considerable interest. On the coast of France it has reached extensive proportions, affording considerable revenue and furnishing employment to thousands of citizens. The industry had its origin in a somewhat romantic manner, about the year 1233. A vessel from Ireland, commanded by a Capt. Walton, was wrecked on the coast of France. Escaping with their lives, the captain and his men erected huts and proceeded to make the best of their misfortunes.

In searching for supplies for food, the observing captain noticed the superior condition of mussels growing on timber elevated above low water, mud and brackish water proving unfavorable for their proper development, and he con-

ceived the idea of building a system of fences covered with brush-work, on which the mollusks could be raised to advantage.

The difficulty of reaching the fences or "bouchots" was obviated by using a flat-bottomed boat or scow, termed an "acon," which was pushed by the foot across the mud surrounding the bouchots. The acons also carried the mollusks when ready for gathering.

In our own country it has not been found necessary to adopt any system of cultivation, the pure waters of Long Island Sound and other coasts favoring their ample growth. Large quantities are pickled and sent into the interior of the country.

October 27th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Sixty-three persons present.

The Chairman of the Special Committee on the Publication Fund, MR. JOHN MCDONALD, made a verbal report of progress.

PROF. D. S. MARTIN, PROF. H. L. FAIRCHILD and DR. N. L. BRITTON presented

NOTES UPON THE RECENTLY-DISCOVERED COLUMNAR TRAP EXPOSURES ON THE EAST SIDE OF ORANGE MOUNTAIN, N. J.

(Illustrated by photographs and sketches by PROF. FAIRCHILD and MR. B. B. CHAMBERLIN.)

(For a description and illustrations of this interesting locality, see Annual Report of the State Geologist of New Jersey, 1884, pp. 23-28.)

MR. ROSSITER W. RAYMOND, PRESIDENT NEWBERRY and MR. F. COPE WHITEHOUSE participated in the ensuing discussion.

November 3d, 1884.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty persons present.

The Report of the Council, recommending elections and the payment of certain bills, was adopted.

Mr. William G. Dewitt and Mr. Justus F. Poggenburg were elected resident members.

A letter from Prof. Dwight, of Vassar College, was read by Dr. Julien, regarding the eggs of *Limulus polyphemus*. The letter was accompanied by specimens for distribution among the members.

(See Journal New York Microscopical Society, i, 47.)

An invitation was read from the Torrey Botanical Club and the Natural Science Association of Staten Island, asking the members of the Academy to join them in a Field Day excursion to Prince's Bay, S. I.

A letter was read from Prof S. F. Baird, asking for photographs of eminent scientific men.

Miss F. R. M. Hitchcock exhibited a specimen of the meteorite containing olivine, which fell at Esterville, Ind., in 1879.

Mr. I. H. Woolson exhibited fragments of charred cloth which had enwrapped a cremated human body found in a mound near Circleville, Ohio.

Mr. P. H. Dudley read a paper entitled,

DESCRIPTION OF THE DYNAGRAPH AND TRACK INSPECTION CAR AND ITS WORK.

(Illustrated by diagrams of the mechanism and charts showing results of track inspections.)

Among railroad people, as among those in other pursuits and vocations, are two distinctive types of mind; one progressive, striving to improve, the other conservative, opposing all changes, until forced to do so by circumstances beyond their control. Nor could we wish to have it otherwise, for the conflict of ideas has garnered the wheat from the chaff, and we have as the substantial result a system of railroads unsurpassed by any other country.

The inception and construction of the oldest part was made but little over half a century ago, while over one-half of our vast system is the growth of the last two decades.

The invention of Bessemer steel, a quarter of a century since, its use for steel rails, other improvements and competition, have reduced the rates of transportation so low that the present charge on a barrel of flour from Chicago to New York is less than an expressman would charge to move it across the city.

How to make these low rates of the past few years meet the necessary outlay is a problem of very difficult practical solution, and it is not strange that there exists great difference of opinion as to the best methods of operation, the selection of material and the best plan of construction.

Conditions on different roads are so dissimilar that in many respects the best plan for one is not necessarily the best for another. The first idea of all railway managers is safety and certainty of movement of trains, and the marvellous success already attained is as wonderful as it is satisfactory. To maintain this with the constantly increasing business and the reduction of rates, will furnish problems of investigation as long as railroads exist. What we consider good to-day, will, in many cases, be found susceptible of improvement by the light of to-morrow. The thousands of young men who have been educated in our colleges the past few years, guided by practical experience on our railroads, are not accepting, without test, opinions and traditions. The struggles of railroads for business is stimulating research in every department, to see whether in some way the cost of the service cannot be at the same time lessened and improved; observations and experiments must be made and the facts ascertained for future guidance.

The desire to know the truth or fallacy of many theories, upon which depended the expenditure of large sums of money under my control as a Civil Engineer, led to the invention and use of the instruments I shall describe and show illustrations and results of their work.

The recording apparatus, shown in Figs. I. and II., is the third one in size which I have made to put on more indications of additional data as the investigations have progressed. The first instrument used paper eleven inches wide, the second one twenty inches wide, and the third, the one here illustrated, uses paper twenty or thirty inches wide, as may be desired.

The apparatus is put in a car specially constructed for its use. The recording apparatus shown in Figs. I. and II. is placed upon the floor of the car over a special six wheel truck having

broad tread cylindrical wheels accurately ground. The central pair are 32$\frac{35}{100}$ inches in diameter, and on the axle of these, a worm of 1$\frac{1}{2}$ inch pitch, triplicate teeth, drives the worm wheel and shaft, having three universal joints and one slip joint, which connects with and propels the mechanism of the recording apparatus shown in Figs. I. and II. The truck carries many distinct sets of special apparatus to furnish required indications, the results being electrically recorded by the battery of electro-magnetic pens on the recording apparatus.

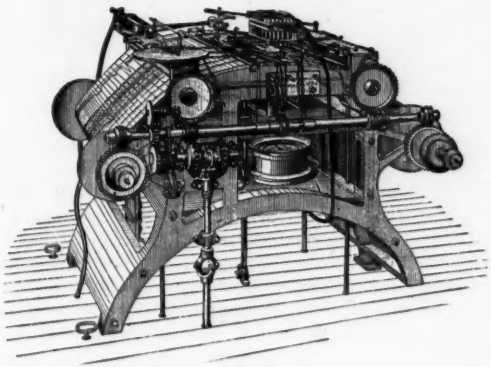


Fig. I

One-twentieth of size.

Fig. I. is a side elevation, and Fig. II. a top view of the recording apparatus. The instrument occupies a floor space of about 34x40 inches, and is 37 inches high; projecting parts extend a few inches outside of these dimensions.

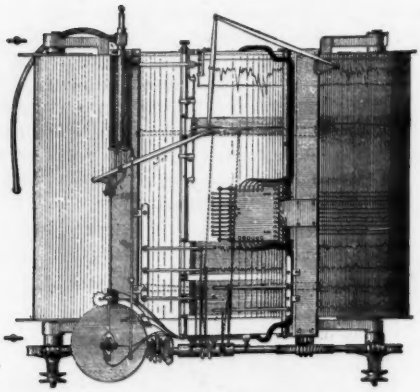


Fig. II.

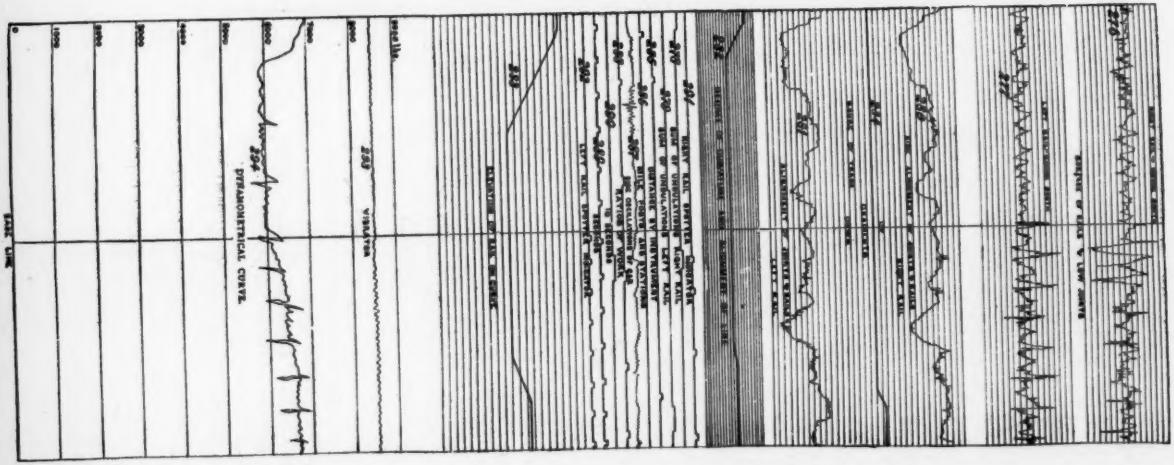
In Fig. II., on either side, may be seen the paper drums, one of which is filled with paper before starting out on a trip; about 1350 feet in length of 60 pound paper can be put on one drum, sufficient for a trip of 150 miles, when inspecting track. As the car moves, the paper is drawn through the instrument, under the various pens, by the opposite pair of feed rolls, and wound upon the other drum or run on to a table for counting and tabulating the data as the trip is made. The paper is fed through the feed rolls, in exact proportion to the distance run—the paper drums being simply receptacles for the paper, and only affect the proper tension as it is being paid off or re-rolled.

By change gears, the feed rolls will pass either one inch of paper for each 50 feet, 100 feet, or 200 feet of track, as may be desired, using respectively 8.8 feet, 4.4 feet, 2.2 feet of paper per mile. The first mentioned scale is always used when inspecting the track. The shaft which drives the entire machinery from its connection with the axle of the car is seen near the left corner of the figure, while many of the other shafts, which operate special indicators, are also seen.

In Fig. II. are seen the pens, each of which gives special indications. On the upper side, the pen which gives the dynamometrical curve; in the centre, the different electric recording

FIG. III.

Full width, 30 inches. Paper 20 inches wide when simply inspecting track.



pens of apparatus located in various portions of the car and truck; and, on the lower side, the pens which give the indications of the track rails. The first and last are controlled entirely by mechanical motions and connections.

The connections which operate the mechanism to record surface undulations of the rails, are so made as to only transmit the irregularities and deflections of the rails; the up and down motions or jar of the car body are eliminated. This enables the work to be repeated for comparison, and for this reason succeeding diagrams of the same track are of increasing value.

The various indications will be understood by reference to the diagrams shown in Fig. III.

The apparatus, as shown in Figs. I. and II., is arranged to take the dynamometrical curve and inspect the track at the same time. The two distinct operations, however, in my practice are seldom conducted at the same time.

For the dynamometrical work a special draw-bar is required; fastened to the frame work of the car is a fluid chamber, so arranged that any tension or pressure against the draw-bar is communicated through mechanism to the pen which indicates or draws the dynamometrical curve; the greater the tension or pressure of the draw-bar the farther the pen moves from the base line.

The cross-head of the measuring-spring (see Fig. II.) to which the dynamometrical pen is attached carries a rod with a little disc, which moves out or in from the center of the larger disc, as the tension is greater or less on the draw-bar. These two discs form the integrating apparatus which mechanically determines the area of the dynamometrical curve; each revolution of the smaller disc constitutes a ratio of work for definite springs, and is electrically recorded upon the paper, shown by the breaks in line 288, Fig. III.

The ratios are counted and multiplied by a constant for each pair of springs, which gives the foot-pounds of work per mile, or any other selected distance.

The ordinates of the curve can also be measured, and the foot-pounds of work obtained by calculation, but it involves much labor. The speed of the train can be ascertained at any instant, as shown by the chronograph lines 289 and 290, indicating seconds and ten seconds.

A delicate clock movement, with circuit breakers and closers,

indicates the proper intervals, each one being a complete revolution of the circuit-breaker, so that each interval is absolutely the same in time, which is not the case with a circuit-breaker of a wheel composed of many teeth.

The lines which show the consumption of each cubic foot of water, each 25 or 50 lbs. of fuel, velocity of wind, revolutions of drivers, intervals of firing, and duration of black smoke are not here shown, as the indications are made through some of the electric recording pens, which are similar to those giving electrical records regarding the track on Fig. III.

Any special piece of electrical recording apparatus can be put in circuit with a pen, and its indications recorded. The dynamometrical curve shown on Fig. III. was from a heavy freight train, moving at about 14 miles per hour on a line of short curves. The fluctuations of the line for each revolution of the drivers is very slight here; sometimes it varies 1000 to 2000 lbs. per revolution, when a large freight locomotive is working nearly to its maximum power.

On the right may be seen the effect of poor joints and rails. A short diagram, representing but a portion of a line, gives but little idea of the fluctuations of a dynamometrical curve of a train drawn over a division of a railroad. A tabulation of the data per mile gives but little in regard to the details of the fluctuations due to topographical features of the line, or local conditions regarding the track.

In starting a train the locomotive usually works for a few feet up to its full tractive power, from 12,000 to 20,000 lbs., according to capacity and size of train, then the line falls as the speed increases, quite rapidly at first and then slower until the curve reaches a comparatively uniform height for the tractive power exerted by the locomotive, generally about one-fourth of the amount used in starting. All movements of the cut-off, up or down, or of the throttle valve, in or out, are shown by the curve. Aside from all other conditions, each engineer, especially on a freight train, gives the curve a personal equation, a good one, if he is a first-class runner, thoroughly acquainted with the line, so he is able to work his locomotive to the best advantage, saving in fuel and time. Such engineers can draw more cars, with a given locomotive, than those who are not so well versed.

The original diagrams, representing the dynamometrical curve together with the chronograph line, set forth what is

being done at all points—the power exerted, the hard places of the line and the manner in which the train was run—giving a series of facts for study which cannot be ascertained otherwise. But few railway people have seen such diagrams, therefore their great value as a means of pointing out where economies can be made is not understood or appreciated. Employees must, in many cases, understand why, as well as how, certain duties are to be performed in order to obtain the best results.

The apparatus is so arranged that experiments can be made with single cars, locomotives, freight and passenger trains. Considerable work with the present instrument has been done upon passenger trains, showing that as the weight and length increases the friction per ton decreases. For trains of 10 cars, 250 tons, about 650 feet in length, speed 48 to 50 miles per hour, the friction was only 10 to 11 lbs. per ton, instead of 16 to 18, as given by most formulas. The expenditure of horse-power on the train alone was 600 to 700 per mile. The speed of the train was limited by the steam generating capacity of the boiler, instead of the tractive and adhesive power of the locomotive.

The ratio of adhesion of a large number of locomotives for summer service I have found above 33⅓ per cent. on good tracks and slow speeds.

The first dynagraph was made in 1874, while I was Chief Engineer of the Valley Railway of Ohio, put into use in 1875, and continued to 1878, when the scope of the investigations required more apparatus than could be attached to that one. The first instrument used paper 11 inches wide and from 12 to 24 inches in length per mile of track; it gave a dynamometrical curve, speed per second, velocity of the wind, and had accessory apparatus to show the consumption of fuel and water used per trip. With this instrument, in the winter of 1875–'76, many experiments were made with freight trains on various roads, and a special series on the Lake Shore and Michigan Southern Railroad, over particular divisions, and through from Buffalo to Chicago, and *vice versa*. On freight trains of thirty to forty eight-wheeled box-cars, gross load 600 to 800 tons (2,000 pounds each), the average friction per ton per foot ranged from 6 to 7½ pounds for speeds from 10 to 12 miles per hour, with but slight increase until we passed twenty miles. This refers to the long run, and not the starting of the train. On many miles of level

track in good condition the friction per ton would only be from 4 to 4½ pounds per ton. The latter may be taken as a fair average for our cars of a gross load of 25 tons, and track in best condition.

The grades upon two divisions of the Lake Shore and Michigan Southern Railroad are short and do not exceed 18 feet per mile, while on some of the others they run up to 40 feet per mile. Most of my experiments were made upon the lighter grades, and I found for freight trains that the locomotive gave a much more economical development of power at 18 to 20 miles than at the slower rate of 10 to 12 miles per hour. The consumption of fuel was from 12 to 20 per cent. less. These ascertained facts were derided by the officials, who said it could not be possible. The higher speeds were however continued, and have been finally adopted, proving far more economical in all respects. The saving in running time of a car from Chicago to Buffalo was twenty-four hours, and a corresponding saving in time of engine and crew over each division, further giving to the road a much greater capacity with the same equipment. The same officials, last July, 1883, said that "the increased economy due to the higher rate of speed proved to be very great, and now oftener exceeded that rate of speed than ran below it."

The average cost per ton per mile for freight in 1876 was .56 of a cent, and for 1880, 1881 and 1882, about .43 of a cent. Part of this reduction was due to the increased speed; the track was improved but little.

TRACK INSPECTION APPARATUS.

Making experiments on the principal railroads, it was soon noticed that the condition of the rails and track exerted much more influence upon the traction of cars than was supposed, upon what were called first-class tracks; so that formulas obtained from experiments upon one railroad did not apply closely upon another road. In these questions average results are not what is desired, as in the end they are misleading. The minimum and maximum results for particular miles are those of special value. Studying the minimum results led at once to the fact that the condition of the track was one of the most important elements of the total resistance to trains, and must be considered in making comparisons. The sections of rails in use were so different, their moments of inertia so unlike, that there

is great difference of opinion as to what is good track. The question must be determined in reference to some standard, independent of personal opinion. To determine this the special track inspection apparatus about to be described was designed. Its present construction is the result of many years of labor, experiment and expense.

A long special 6-wheel truck has been constructed for this purpose, after many experiments with other kinds of trucks, the principle being to use the outer wheels as a definite length of measuring plane, and record the undulation of the rails in this length by a third intermediate pair of wheels. Mechanical movements communicate only the undulation of the rails to the paper, all other movements of the car body and truck being eliminated. Working from a plane as a basis of the measurements and delineations of the undulations of the rail, gives to them a character and accuracy which is very surprising to those not familiar with the diagrams. In many instances, when the rails have only been in the track two or three years, the exact rail where different brands join is at once seen, owing to some slight difference in methods of manufacture, care in finishing the product and the quality of the steel.

From the character of the delineation it is at once seen whether the rails are rough and bent, joints low, worn out, or loose on the ties, and whether any permanent improvement which can be made by labor or new material is required.

It was supposed by many engineers that on the best tracks laid with 65 or 67 pound rails, we would find rails without any undulations. This has not been the case under the weight of the car, and is hardly possible, as there are deflections which take place under the wheels of the locomotives, springing back to surface when the loads are removed and pass unnoticed until a more or less permanent set in the rails takes place.

The original diagrams of track inspection have demonstrated that the deflections were more than was generally supposed, and has led to the introduction of much stiffer as well as heavier sections of rails.

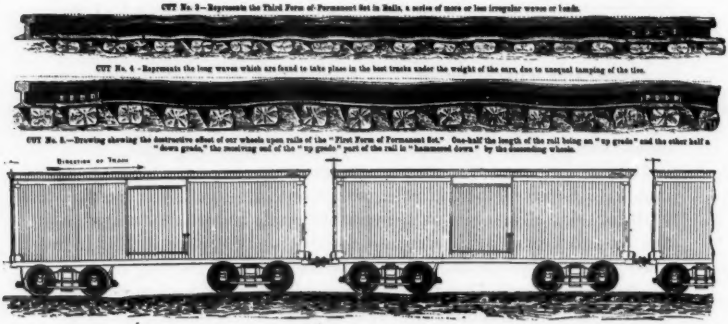
The recent 72-pound rail of the Boston and Albany R. R. shows reduced deflections, while the 80-pound rail, five inches high, of the New York Central and Hudson River Railroad, shows still further reduced deflections.

A comparison of the diagrams from different railroads showed

that the rails assumed definite forms in the track due to their permanent set. The extent of the permanent set in the rails, or the rapidity of its taking place, has quite definite relations to the section of the rail, weight per yard, ballast, system of laying the joints, traffic and care the rails receive in the track.

The care and finish of rails in manufacture is also an important element, increasing in its noticeable effects as the standard of track rises. The smoothness of the surface of rails determines to a great extent the degree of perfection the trackmen can surface the rails; they can remove long bends, but not the short ones in the rails. I have classified to date the permanent set found in rails under three principal Primary Forms, represented by cuts numbers 6, 7 and 3; there are often combinations of the 1st and 3d, and the 2d and 3d.

Forms of wear are quite distinct from these, though, when the steel is not homogeneous, one form appears on the surface somewhat like cut No. 3.



CUT No. 3.—Represents the Third Form of Permanent Set in Rails, a series of more or less irregular waves or bends.

CUT No. 4.—Represents the long waves which are found to take place in the best tracks under the weight of the cars, due to unequal tamping of the ties.

CUT No. 5.—Showing showing the destructive effect of our wheels upon rails of the "First Form of Permanent Set." One-half the length of the rail being an "up grade" and the other half a "down grade," the receiving end of the "up grade" part of the rail is "hammered down" by the descending wheels.

Cut No. 4 shows, to some extent, the characteristic deflections or undulations which even the smoothest rails assume under heavy cars, due to looseness and unequal tamping of the ties; with double-angle plates in good condition, the wave of one rail is carried to the succeeding one, practically making A CONTINUOUS RAIL.

Rails like No. 4 appear in good surface when not under trains, and are really what should be called the Third Form.

The Third Form (see cut No. 3) represents, on a more or less exaggerated scale, bad surfaced rails as they come sometimes from the MILLS. Such rails are called "Rough Rails" in the Book of Tabulations, and give to the moving cars a very decided series of shocks, making an unpleasant motion for passengers.

CUT No. 6.—Represents the First Form of Permanent Set in Rails, low at the joints and high in the center.

CUT No. 7.—Represents the Second Form of Permanent Set in Rails, low at the joints and center and high at the quarters.

The Second Form (see cut No. 7) develops from the Third by service as soon as the joint becomes weak or worn, and if allowed to continue develops into the First Form.

A large number of new steel rails, from not being properly straightened, have short vertical bends at and near the joints, which cannot be improved by the trackmen; consequently, the joints are low and the wheels pound them when new.

Cuts Nos. 6 and 7, besides representing the 1st and 2d Forms of Permanent Set in rails, show the receiving ends cut out by trains running in one and the same direction, as that shown in Cut No. 5.

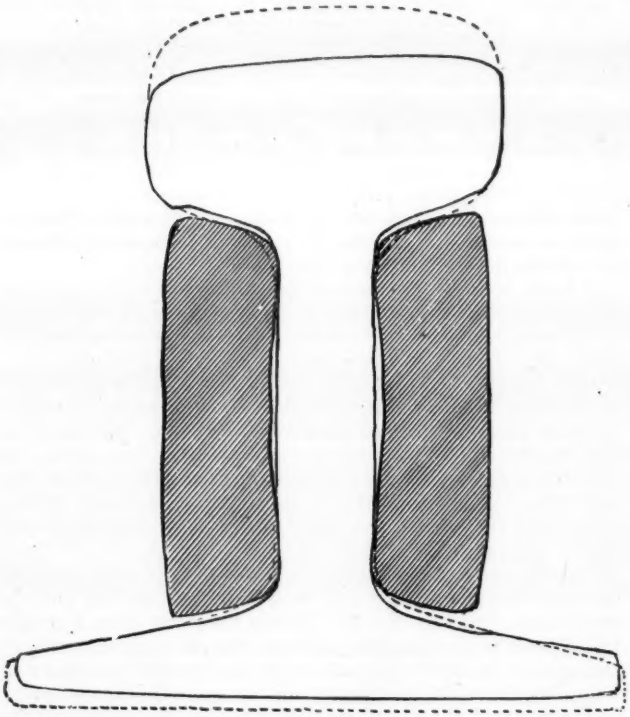
This has proven to be a very serious matter, the ends of the rails being so badly injured as to prevent the surfacing of the track, until taken up, the injured portion cut off, redrilled and relaid.

On rails of the First Form (see Cut No. 6), in most cases the fish-plates will be found worn, bent, or broken, and the joint tie or ties loose (see Cut No. 8). This is the worst form the rails are allowed to assume, from the fact that the receiving ends of the rails are rapidly "cut out" under heavy traffic (as shown in Cuts Nos. 5 and 6), and the cost of transportation increased.

The wear of fish-plates, as shown in Cut No. 8, or even the upper edge of angle plates, is far greater than is generally supposed. The renewal of the plates, even on old rails, has been of greatest service on some roads in maintaining good and easy riding tracks.

Cut No. 8 shows the wear on the edges of the ordinary fish-plate at the end of the rails; also the wear of the shoulders of the rails. The ends of the fish-plates are unworn, and appear tight and firm to the trackmen. The BOLTS may be screwed up solid, yet the ends of the rails are free to move down and up

Cut No. 8.



upon the passage of the trains, and are more or less cut out, like those shown in Cuts 5, 6, and 7. The dotted line under the base shows the loss of metal from wear on the joint tie.

The smoothest riding track is where the rails, like Cut No. 4,

have the joints so firm as to carry the wave or deflection of one rail to the next, and not allow it to break at the joint.

The original diagrams taken by the instruments, showing the general condition of the tracks, were of such extent that much time was required to approximately summarize the results, and limited the number of roads which could be inspected. This led to the design and construction of the summing-up apparatus.

These are without question the most valuable of all pieces of the accessory apparatus connected with the car, as they give results independent of every other mechanism and personal opinion. They measure and sum up the smallest possible undulation or the greatest with equal facility, and when the sum equals 6 inches in amount of vertical up motion of the intermediate wheel, make records as shown on lines 278 and 279 on Fig. III. They furnish the means of showing whether improvements are being made in the track or whether it is deteriorating from month to month or year to year. The summing-up apparatus gives the figures which form the basis of the condensed diagrams. from which at once is seen the relative and comparative condition of each mile of track, and further the comparisons between different brands of steel and their smooth-wearing qualities. Officials can, in a few moments, see the entire condition of their line, and if they have them for more than one year, can see the effect of a particular policy or system they may adopt in regard to their track, by comparing with a diagram taken at some preceding date. The condensed diagrams give in lines the results of the figures, showing the essential details of each mile. A strip of paper 36 inches long and 9 inches wide is sufficient to show 150 miles of double track. The tabulated figures occupy about 40 pages, 11 x 17 inches.

LOW POINT MARKERS.

To indicate to the trackmen where the deflections in the rails occurred, under the weight of a heavy car, or loose or worn joints, without further reference to the diagrams, the "Low Point Markers" were added, which, as the car runs over the track, ejects paint under the heads of the rails when the deflections equal or excel what the markers are set to discharge. At first this was five-sixteenths of an inch, but now reduced to three-sixteenths of an inch on several railroads. *

* In 1886, to one-eighth of an inch, and for the Boston and Albany R. R., 3-32 of an inch.

The "Low Point Markers" are carried by auxiliary inflexible bars, connected directly to the journal boxes of the outer wheels; the intermediate wheel carrying the striker. The "markers" are operated by compressed air—of 60 to 75 pounds pressure—from the air-brake reservoir. Resting upon the bars is a cylinder with piston, the rod extending below, and forming the plunger of the pump which ejects the paint; the pressure on the fluid is from 150 to 200 pounds per square inch. Each "Low Point Marker" has a slide valve raised by springs, so that when the striker is off the valve-stem, the air and fluid piston is raised; when the intermediate wheel, which carries the striker, goes into a depression below what the instrument is set to mark—five-sixteenths of an inch, or less,—the valve is depressed, cutting off and releasing the air from the under side of the piston, admitting the air above, forcing down the piston, and ejecting the paint under the head of the rail where there are deflections for want of proper tamping, deflections over rotten or loose ties, bad bends in the rails, weak or worn-out joints, etc. The color will last from four to six weeks, showing to trackmen where their labor is needed.

Deflections in the rails under the trains occur of more or less extent, and a permanent set takes place, of some of the forms shown in the cuts. The trackmen do not see these deflections when they first occur, and it is not until the rail has acquired some permanent set that they give them attention.

Roads have been brought to a much better condition of track by the car passing over periodically, and having the surfacing done according to the indications of the "Low Point Markers," —*directing the labor to the points where it was needed, and saving much which is unnecessary.*

The business on our trunk-lines is now so great that a slight difference in condition of track increases the operating expenses in a far greater ratio than most railway men believe.

The dominant Form in which rails are found in a track is a reliable indication as to the cost of freight-car repairs and the cost of transportation. A road in 1881, with rails of the 3d and 2d Forms, doing a business of 2,688,412,481 ton miles: the cost of freight-car repairs per ton mile was $0.00 0335.

Another road, same year, rails of 1st Form, doing a business of 2,705,165,840 ton miles: the cost of car repairs per ton mile

was $0.00 0701—over double—while the increased cost of transportation was over 1 mill per ton mile.

Under heavy traffic the wear of the rails has been quite different from what was anticipated, after the experience with the light steels, which were first used after the iron rails. The wear of the heads had been so favorable and lasted so well, that deeper heads were designed for subsequent sections.

These have not given the same relative wear per ton as the first sections, nor worn as smoothly, and are removed from the track on account of roughness, before the loss of metal would render them insecure. The light bases of rails have also shown so much wear as to require removal on that account.

The study of all these forms of wear, the possibilities of manufacture, led me to the design of the 80-lb. rail for the N. Y. C. & H. R. R.R., a section being before you. It has a very shallow but broad head, made so in order to reduce the speed of the vertical wear. By increasing the wearing surfaces, the rapid reciprocal wear of the treads of the wheels will also be reduced.

The distribution of the metal was carefully considered, and put in position for wear and strength. It is much stiffer, nearly 25 per cent., than the Metropolitan (of London) section, which weighs 90 lbs. The maximum width of the head is $2\frac{3}{4}$ inches; curves of upper corner, 5–16 of an inch, and radius of head, 12 inches. The actual wear of the rail in the track is over the entire surface of the head when new, and not confined to the center, as with heads of shorter radius.

November 10th, 1884.

STATED MEETING.

The President, Dr. J. S. NEWBERRY, in the chair.

One hundred persons present.

PROF. H. L. FAIRCHILD read a paper on

ELEPHANTS, ANCIENT AND MODERN, WITH REFERENCE ALSO TO THE EXTINCTION OF THE MAMMOTH; AND NOTES ON THE SMALL ELEPHANTS LATELY BROUGHT TO THIS CITY FROM FARTHER INDIA.

(Illustrated with lantern views.)

(Abstract.)

Affinities of the Proboscidia.—The Proboscidia are allied to the Ungulata, but are not strictly either Artiodactyla or Perisso-

dactyla. They have affinities with the Rodentia (re-curved spine on the scapula, and two anterior venæ cavæ), and also with the Sirenia; the limbs are low in structure.

General Characteristics of the Proboscidia.—The living forms stand by themselves, alone, unique. In some points they have a low or generalized structure. They are highly specialized in other points, as the skull, teeth and proboscis. Their ancestral forms are found in the Eocene.

Geological History of the Proboscidia.—

	AMERICA.	EUROPE.	ASIA.
Eocene.	*Dinocerata* and ancestral forms (doubtfully proboscidian.)		
Miocene.	*Mastodon.*	*Dinotherium* (3 species) *Mastodon* { *longirostris* / *tapiroides* *Elephas* (5 species).	*Dinotherium.* *Mastodon* (4 species). *Elephas* (7 species).
Pliocene.	*Mastodon* { *mirificus* / *productus.* *Elephas* { *Americanus* / *imperator.*	*Mastodon* { *angustidens* / *avernensis.* *Elephas meridionalis.*	*Mastodon.* *Elephas* (several species)
Pleistocene.	*Mastodon* { *Americanus* / *Humboldtii.* (South Am.) *Elephas* { *primigenius* / *Americanus* / *Columbi.*	*Elephas* { *primigenius* / *meridionalis* / *antiquus* / *Africanus* / *Melitensis* / *Falconeri.*	*Elephas primigenius.*
Historical			*Elephas Indicus.* *Elephas Africanus.* (In Africa.)

The greater number and variety are found in the geological formations of the East.

Elephus is an Old World type which appeared in America in the Pliocene (two species). In the Post-Pliocene (Pleistocene) the *Elephas primigenius* ranged over all the Arctic region.

Elephas Americanus roamed southward and northwestward from the Gulf of Mexico to Alaska. It had fewer plates of enamel in the molars, and the tusks were straighter. Some palœontologists regard it as only a modification of *E. primigenius.*

Fourteen extinct species of *Elephas* are known, and about twenty species of *Mastodon.*

Description of Elephas.—There are two living species, the Indian and African, which are but a remnant of the host of earlier times.

Feet: Toes, five; outer pair more or less rudimental; nails, in the Indian, five and four, in the African, four and three.

Tusks: Enamel confined to apex and soon worn away. In the *Mastodon* the enamel was in longitudinal bands. The tusks are developed in the premaxillæ, but for solid support sink into specially developed aveolar processes of the maxillæ. The curvature and size vary somewhat according to the food. Deciduous tusks appear from the fifth to the seventh month, about two inches long and one-third inch diameter. They are shed before the second year. The permanent tusks grow two months later.

Molars show a modification from those of the *Mastodon*, similar to the change from the *Palœotherium* to the horse. Occasionally a rudimentary molar is found in front, which makes the typical seven. Only the last three are true molars. These teeth are replaced horizontally, and only one or a portion of two are in use at once. The dental changes require the entire life of the animal. The other extreme is found in *Dinotherium*, where all the molars are in use at once, and the milk molars are displaced vertically. *Mastodon* exhibits a transitional form.

The molars consist of vertical plates of dentine, covered with enamel and solidified by cementum. As the wear comes first on the anterior portion of the crown, the corresponding part of the root is absorbed, which thus permits the pushing forward of the tooth.

E. Africanus has lozenge-shaped divisions of the crown, with fewer and larger plates and thicker enamel than those of *E. Indicus*, which has the plates thin and parallel. *E. primigenius* had the laminæ thinner, and rather more numerous than *E. Indicus*, with the lines of enamel more slender and less festooned; and the molars were relatively and absolutely wider.

The first molar, with four plates, appears when the animal is

a few months old, and is shed at about the end of the second year. The second, with eight plates, is worn for eight or nine years.

Table of Dental Formulæ.—

	Incisors.	Canines.	Premolars.	Molars.	
Elephas primigenius,	$\frac{1-1}{0-0}$	$\frac{0-0}{0-0}$	$\frac{6-6}{6-6}$		=26
Elephas Indicus,	$\frac{1-1}{0-0}$	$\frac{0-0}{0-0}$	$\frac{6-6}{6-6}$		=26
Elephas Africanus,	$\frac{1-1}{0-0}$	$\frac{0-0}{0-0}$	$\frac{6-6}{6-6}$		=26
Mastodon,	$\frac{1-1}{1-1, \text{ or } 0-0}$	$\frac{0-0}{0-0}$	$\frac{6-6}{6-6}$		=26 or 28
Dinotherium,	$\frac{0-0\ (?)}{1-1}$	$\frac{0-0}{0-0}$	$\frac{2-2}{2-2}$	$\frac{3-3}{3-3}$	=22

Table of Ridges or Plates in the Molars.—

	First Molar.	Second Molar.	Third Molar.	Fourth Molar.	Fifth Molar.	Sixth Molar.
Elephas primigenius,	4	8	12	12 or 14	16 or 18	24
Elephas Indicus,	4	8	12	12	16	24
Elephas Africanus,	3	6	7	7	8	11
Mastodon,	Never over five.					

Skull.—Large, cellular, empty spaces or air-cells, highly specialized; brain cavity small.

Brain.—Cerebrum large, highly convoluted; cerebellum much exposed.

Skeleton.—Dorsal region of vertebral column long; only three lumbar vertebræ; four sacral vertebræ; the centra flattened; neck short; knee-joint low, giving the impression of the joints bending in the wrong direction.

Growth and Size.—The new-born are about three feet high. They nurse nearly two years, become four feet high in the

second year, and mature in thirty years, when they are not over eleven feet high. Toward the equator the height decreases but the tusks lengthen.

The young of *E. Indicus* are born with a coat of wool. In the elevated districts of Northern India, and in Sumatra, the young are more hairy than in warmer regions.

Description of the Mammoth (*Elephas primigenius*).—This is the most highly specialized species: the "king of elephants." It is closely related to *E. Indicus*, some naturalists regarding the species as a variation of *Indicus* produced by climate, food, etc. The tusks had greater and varying curvature. The skull had great length and perpendicularity in the sockets for the tusks, the long alveoli giving a strange physiognomy. The head was long, occiput high, forehead concave and nearly vertical. Molars were variable, wider than in *Indicus*, lower ones parallel; ridges closer, lines straighter. The hair was of three kinds: (a) coarse, brown, horse-hair like, 12-15 inches long; (b) delicate, fawn colored, 9-10 inches; (c) fawn-colored wool, fine, 4-5 inches. In size, stouter and clumsier than modern elephants, but not taller in general. Habitat: most numerous furthest north; not found in the elevated districts, and not south of 40° N. Lat.; found in Italy. Their fossils are very abundant in some parts of Siberia. Several varieties are noted, according to the thickness of the enamel ridges; the thin-plated variety found northward.

Comparison of the Proboscidia.

	MOLARS.	TUSKS.
Elephas,	Flatened surface; replaced horizontally; occasionally a rudimental front molar; only two in use at once.	Enamel on apex, and soon lost; two milk tusks.
Mastodon,	Conical cusps; replaced partly vertically; enamel thick, cementum scanty; perhaps three in use.	Enamel in longitudinal bands; sometimes in lower jaw.
Dinotherium,	Crowns like those of the Tapir; all molars in use; milk molars displaced vertically.	Tusks in lower jaw, directed downwards.

Comparison of Elephas.

	Teeth.	Head.	Ears.	Back.	Toes.	Hoofs.	Covering.
Elephas primigenius.	Wider than in *Indicus.* Ridges closer. Lower ones parallel.	Elongated. Concave.					Wool, fawn-colored, 4-5 inches. Hair, delicate, 9-10 inches. Hair, brown and coarse. 12-15 inches.
Elephas Indicus.		Concave.	Small.	Convex.	5	5—4	Sparse Bristles, more on head.
Elephas Africanus.	Lozenge-shaped divisions.	Convex. Narrow Occiput.	Large.	Straight or Concave.	5	4—3	Sparse Bristles.

The small elephants referred to in the title had been much noticed in the public press as "dwarf" elephants, and as degraded "mammoths." The taller one was under three feet in height, and was black, with coarse, shining, bristle-like hair. This hair was thicker and longer about the shoulders and head, forming on the forehead a decided "bang." The smaller individual, not over two and one-half feet high, was not so hairy. The hairiness was their chief peculiarity, other features resembling the young of *E. Indicus.* They were described with some minuteness, and their reputed but evidently untrue history given, and photographs of them were exhibited. The opinion was expressed by the author that they were young Indian elephants, perhaps from Sumatra, which had been "doctored."

November 17th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Seventy persons present.

PROF. O. P. HUBBARD exhibited a portion of the skin of the Siberian Mammoth now in the museum of St. Petersburg,

and gave an account of the discovery of the carcass in ice deposit in 1789, and its condition when obtained in 1806.

He also showed a fragment of a very large basaltic boulder in Woodbridge, Conn., which lies on a ridge of talcose and chloritic slate, five miles west of New Haven, and west of West Rock, and at the height of the latter—400 feet above sea level. The boulder measures 45 x 25 x 15 feet (20,304 cubic feet), and is surrounded by many others. From their structure, Prof. Dana traces them to the Meriden Hills, 1,000 feet elevation, from whence they have been carried twenty miles by a glacier.

Mr. GEORGE F. KUNZ showed Schorlonite with a metallic luster, and rose quartz from Maine.

PROF. FAIRCHILD made remarks additional to his paper of the last meeting. He had received positive information that the diminutive elephants were from Sumatra. They were the young of *E. Indicus*, and had been stunted in growth by lack of proper food. Their unusual growth of hair had been made black and shiny by application of glycerine, etc.

PRESIDENT NEWBERRY remarked upon the extinction of the Mammoth.

MR. F. J. H. MERRILL then read the following paper:

ON THE GEOLOGY OF LONG ISLAND.

(Illustrated by specimens and charts.)

[Published in the ANNALS, vol. iii., pp. 341–364; plates xxvii. and xxviii.]

November 24th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Forty persons present.

MR. GEORGE F. KUNZ exhibited and described a large suite of gems and gem-minerals.

DR. N. L. BRITTON read a paper entitled:

NOTES ON THE GLACIAL AND PRE-GLACIAL DRIFTS OF NEW JERSEY AND STATEN ISLAND.

(Illustrated with specimens and lantern views.)

The terminal moraine of eastern North America extends from the Southeast corner of Cape Cod, across Nantucket, Martha's Vineyard and Block Island, and runs through the centre of Long Island for its whole length; it crosses New York Bay at the Narrows, follows a curved line across Staten Island, meets New Jersey at Perth Amboy, and takes a sinuous course across that State to Belvidere on the Delaware River, where it enters Pennsylvania. Further west than this point it is unnecessary to trace it in the present paper.

The river valleys, particularly those of the Delaware and Raritan, which head in the glaciated region north of the line above traced and terminate south of it, have served as channels for the further distribution of the Glacial Drift, while along the coasts the action of the sea during the periods of depression has given us extensive areas of stratified, *modified* Drift.

The material known as the Yellow or Pre-Glacial Drift, to which attention is directed in the present communication, is distributed along the Atlantic Border, from the coasts of the Southern States northward to the moraine, which it underlies unconformably, and by which its extreme northern limit for the country east of New York is concealed and at present undeterminable. Its inland distribution is not extensive, and is apparently determined by the altitude of the country above the sea. It is found in southeastern Pennsylvania and covers the entire State of Delaware, so far as I can ascertain. All southern New Jersey is overspread by it, and the tops of hills in that region are commonly capped with the pre-glacial gravel. Some of these hills attain elevations of three to four hundred feet. Their presence is due to the erosion of the surrounding country.

The contact of the two drifts is observable in but few localities. Their relation was first definitely made known by Professors Cook and Smock, of the New Jersey Geological Survey,* during their study of the Plastic Clay Series in Middlesex

* Report on Clays, 1878, p. 120, etc.; see also Ann. Rep. State Geologist, 1880, p. 88.

County, where the Glacial Drift was found resting upon the yellow sand and gravel, the line of demarkation being sharply defined. I visited some of these localities last September with Professor Cook, and was impressed with the contrast in appearance between the two formations, the upper, glacial deposits being markedly red from the abundance of red triassic shale and sandstone, here the most abundant rocks of the moraine. The yellow, pre-glacial drift at these points rests directly on the Cretaceous strata, being immediately in contact with a red clay on the Forbes Farm near Woodbridge,* and with a white fire-clay at Inness' pits, the clays underlain by a bed of feldspar in small fragments.

The modified glacial drift of the lower Delaware Valley overlies the pre-glacial drift unconformably, from Trenton, where the contact is well exposed, to Philadelphia, where they have been studied and described by Prof. H. Carvill Lewis.† From his observations it appears that about Philadelphia there is quite a series of quaternary deposits overlying the pre-glacial drift.

The materials composing the pre-glacial drift are remarkably constant in character. They consist of gravel varying in size from pebbles somewhat larger than a hen's egg to a fine sand, which in some places is slightly charged with clay. The bulk of the formation is, however, coarse, and frequently exhibits the "flow and plunge" structure and cross bedding, indications of its deposition in disturbed waters. These sands and gravels are mainly of quartz; the pebbles and grains are very generally rounded, though angular fragments occur. The whole formation is light-colored, generally yellow, and varying to white. Examination of the larger pebbles shows that the yellow coloration is superficial; they are lighter in tint and sometimes white within. The hydrated oxide of iron, to which the color is due, is discharged by warm hydrochloric acid. These facts indicate that this coloring has obtained since their deposition. The presence of numerous beds of limonite, associated with the gravels and sands, gives a clue to the origin of the yellow color. It would seem probable that the whole formation has been saturated with iron oxide, which has locally been in sufficient amount to cement the materials into a brown

* Ann. Rep. State Geologist, 1880, p. 90.

† Journ. Franklin Inst., June, 1883.

sandstone, or conglomerate,—the "Brown Sandstone Formation" of the older Rogers* in part. Associated with the sands and gravels are locally distributed angular or slightly rounded masses of a white, granular quartzite. These are generally flat, and reach a thickness of a foot or more, some of them weighing not less than one hundred pounds. They resemble some of the Oneida sandstone of the Kittatinny Mountains. They occur scattered over the surface of the country around Woodbridge, N. J., and elsewhere on both sides of the Raritan River, and I have also seen them in the southern part of the State. Whether or not these slabs of sandstone are a part of the Pre-glacial Drift, or of subsequent deposition, I am as yet unable to determine.

A peculiar and hitherto unexplained feature of the Pre-glacial Drift is the presence of palæozoic fossils in many of the pebbles. I have found these in numerous localities, and proper search would doubtless reveal them throughout the entire extent of the formation. Many of them are contained in pebbles of lower specific gravity than quartz, reminding one strongly of a silicious limestone from which the calcareous matter has been leached. Prof. R. P. Whitfield has examined and determined some of the species represented in the collections of the New Jersey Survey,† and many others can now be added to his list. They are Upper Silurian and Devonian: corals, crinoid stems, bryozoans, brachiopods, lamellibranchs, cephalopods, and a single fish-tooth are recorded. The original source of these fossils is an unsolved problem.

The thickness of the Pre-glacial Drift is apparently greatest over and near the Plastic Clay Series, and here also is it coarsest; it is a most irregularly distributed deposit, however. Its greatest depth may be safely placed at not less than forty-five feet, while at points within gun-shot of a great thickness there will be little or none.

For a detailed description of the pre-glacial deposits of Long Island I would refer to Mr. Merrill's paper of last Monday evening, noting only the presence of the formation over all the island south of the moraine, and also its occurrence in the form

* Rep. on Geology of New Jersey, 1857.

† New Jersey Geol. Surv., Rep. on Clay, 1878, and Ann. Rep. State Geol., 1880, p. 92.

of laminated yellow sands over the cretaceous beds at Glen Cove.

The Pre-glacial Drift of Staten Island is for the most part concealed by the moraine and the modified Glacial Drift resulting from the wash of the morainal deposits by the sea during periods of depression accompanying or succeeding the ice period. I have noticed it well exposed for study in but four localities: on Todt Hill, at Prince's Bay Light-house, south-east of Tottenville, and about Kreischerville.

The Todt Hill exposure is of great interest. The sand and gravel here reach the thickness of six feet in places, and vary from this depth to a layer of scattered yellow pebbles. The area here covered amounts to several acres, and the elevation above tide is about two hundred feet, indicating a depression of more than that amount during its deposition, and the almost complete submergence in the island at the time. It is here almost entirely made up of gravel, some of the stones reaching two inches in diameter, but there is also sand, and I have recently seen a single band of a drab-colored clay. The deposit is stratified throughout, and very irregularly so, cross-bedding being prominent. The immediate underlying material is limonite, on which it rests unconformably, and fragments of this material are to be found in the gravel. However, the deposition of the iron oxide went on after that of the gravel to a certain extent, for the peculiar conglomerate formed by the cementation of the latter by the former material is to be found in small quantity in the gravel beds. I am inclined to believe that the epochs of deposition of the two were immediately consecutive. In a former paper on the Geology of Staten Island,* I suggested that the gravel deposits here described might perhaps be referred to the modified Glacial Drift, their position immediately south of the moraine giving rise to this impression. At that time I was not familiar with the Pre-glacial Drift, and my idea there stated is erroneous. The limonite rests immediately on the serpentine rock, which forms the entire range of high hills of Staten Island.

On Todt Hill, as elsewhere, the Pre-glacial Drift contains pebbles with palæozoic fossils poorly preserved. I have here found crinoid stems, a *Fenestella*, a *Favosite*, and one or two Brachiopods. The gravel is used in road-making, and the

* Annals of this Academy, ii, No. 6, p. 175, 1881.

excavations are now in a fine condition for study. The ice masses of the glacier came very near this gravel deposit on Todt Hill, but I have not yet succeeded in finding the two drifts in contact at this point. The Glacial Drift fills a valley a few hundred feet west of the spur occupied by the Preglacial Drift, and the main mass of the moraine is less than half a mile distant to the north and west.

"The bluff on which the light-house stands at Prince's Bay is a prominent feature in the topography of the neighborhood. It is probably the best exposure of Glacial Drift that we have in the vicinity of New York, for here the terminal moraine of the great North American Glacier has been cut down through the greater part of its thickness, for a distance of nearly a half mile along the shore leaving a steep bluff, which reaches some seventy-five feet in height, filled with pebbles, stones and boulders of transported materials, among them some brought from at least two hundred miles to the north, and many smoothed and rounded and bearing the characteristic scratches and groovings, which it is well known that moving ice masses only produce. Here, for example, were found Potsdam Sandstone with the fossil worm *Scolithus;* the Lower Helderberg Limestone, with other well-known fossils: *Strophodonta Beckii*, *Spirifer macropleurus*, and *Strophomena rhomboidalis*, for example; Oriskany Sandstone with *Spirifer arenosus* and *S. erectus:* these are found in places in Northern New York; also Gneiss, probably originating in the New Jersey Highlands; and, most abundant, the red sandstone and trap rocks of New Jersey.* This part of the moraine was evidently deposited under water, as it shows well-marked lines of stratification, differing in this from glacial deposits further inland. The most interesting feature of this hill is, however, one which had hitherto escaped our notice. I refer to the masses of Cretaceous plastic clays with the overlying Yellow Gravel well displayed about Kreischerville, and known to underlie the Glacial Drift throughout Southfield and Westfield, here *imbedded in the moraine*, proving conclusively that in its southward movement the glacier scooped out portions of the strata over which it flowed, and enclosed them in the mixed load of stones, clay and sand which it carried and deposited." †

* loc. cit., p. 174.

† Proc. Nat. Sci. Assn. S. I., Nov. 8, 1884.

East and south of Tottenville there is a stretch of sandy country, in all of about one square mile, which is occupied by the Pre-glacial Drift. There is here comparatively little gravel to be seen. About Kreischerville, where the plastic clay series of the Cretaceous comes to the surface, the yellow sand and gravel may be seen in limited quantity over an area of several hundred acres. At times I have seen the two drifts in contact in the clay pits of this locality, the Glacial invariably uppermost.

The Geological Age of the Pre-glacial Drift.—The Pre-glacial Drift of New Jersey has been exhaustively described in the reports of the Geological Survey.* Over nearly all of this State, south of the moraine, the yellow sands and gravels are distributed in variable quantity, uniformly non-conformable to the underlying strata. My interest in the formation has been excited during work with Prof. Cook, and the reference to me for examination of a group of fossil plants found in it. The leaf-prints referred to are found near the city of Bridgeton, Cumberland County, and have received considerable study. The stratum bearing these leaf-impressions is a rather coarse, soft sandstone—so coarse indeed, that the margins of the leaves are often very indistinctly preserved, making it difficult to determine the outline. The primary venation, however, and sometimes the finer subdivisions of the veins are easily seen.

The identification of the species represented is not yet completed. Among the genera we have *Liquidambar*, the sweet gum, represented by several specimens of leaves resembling those of the living species (*L. styraciflua, L.*), but only three-lobed, as occasionally seen on young shoots of that tree, and thus resembling one of the Japanese species. Numerous specimens of a *Viburnum*, as shown by the venation, which I have called *V. Bridgetonense*, fragments of a broad-leaved grass, perhaps *Zizania;* serrated leaves of species of *Ulmus* and *Carpinus;* leaves of one or more species of Oak, resembling *Quercus imbricaria*, two species of *Magnolia*, one of them apparently identical with *M. glauca*, the sweet bay; one or two specimens with the venation of *Ceanothus*, and others yet undetermined.†

* Report on Clays, 1878: Annual Rep., 1880, pp. 87-97, and Annual Rep., 1884, incl.

† See Proc. A. A. A. S., 1882, Montreal Meeting, p. 357-359.

The age of these vegetable remains is that of the Pre-glacial Drift. Some of the species represented are still existing in the present flora.

The Pre-glacial Drift inconformably overlies the miocene strata of Southern New Jersey. In fact, the Bridgeton Plant Bed above described is over Miocene materials. It is then Pliocene or yet more recent. I am inclined to regard the formation as later Pliocene or Pleistocene, mainly from the modern character of the plants from Bridgeton, though these cannot be regarded as absolute proof. Silicified wood occurs in the Pre-glacial Drift in considerable abundance. I have examined sections of some of this, and they are of coniferous trees. It may be that a more extended study of the fossil woods may shed more light on this question.

The Origin of the Materials composing the Pre-glacial Drift.—It must be admitted at the present writing, that the location of the rocks from which the pre-glacial gravel and sand have been derived is not certainly determined. Professor Cook has argued that inasmuch as there is no red shale nor sandstone fragments in the formation, it cannot have come from the northwest, for to have been transported from that direction it must have crossed thirty miles or more of Triassic red rocks, and would certainly contain some fragments of these. In fact, he concluded that it must have come from the southeast, and thus from rocks now submerged in the Atlantic. The absence of any known reefs of such rock, or of any indications of their existence weigh heavily against this hypothesis, and it would seem that some other explanation must be found. I am not aware that up to the present time any other hypothesis has been published regarding the origin of these materials.

I will briefly refer to certain facts which may furnish clues in the future study of the formation.

(1) A large part of the gravel is evidently vein-quartz, and thus must have come from crystalline or partially metamorphosed rocks. The former are known to exist along the junction of the Triassic and Cretaceous formations from New York to Philadelphia, and further southwest. It would seem that the crystalline rocks of the Highlands of New Jersey are too far distant to have yielded much of the material, and this taken with the difficulty of its having to cross the red Triassic strata,

before alluded to, enable us, in the writer's opinion, to leave these out of consideration in the discussion.

(2) The fossiliferous pebbles have evidently been silicious limestone. There are no such rocks now outcropping in proximity to the Pre-glacial Drift formation, and they must either have come from the Palæozoic regions northwest of the Kittatinny Mountains, or from rocks now covered by the Cretaceous and newer formations. This is a question on which we are not likely to obtain any conclusive evidence without a great deal of detailed field observation.

(3) There are gravel beds of considerable thickness interbedded with the Cretaceous clays. Mr. Merrill reported last Monday evening a section at Glen Cove, Long Island, seventy-three feet high of interstratified clay and gravel. At Fish House Station, N. J., a few miles above Trenton, the gravel was four feet thick in one of the clay pits when visited in 1883, and in this gravel I found a pebble containing a broken cast of *Atrypa reticularis*. A gravel-bed was encountered in a well bored at Sayreville, N. J., and it has been noticed in smaller amounts elsewhere. Sand-beds are everywhere interstratified with those of clay. It is a safe assumption, I believe, that the origin of these Cretaceous gravels and sands was closely related to, and certainly contemporaneous with the deposition of the clays. The clays are generally believed to be the result of kaolination of the feldspars of crystalline rocks; everything points to the truth of this hypothesis, and indeed at Trenton the process may actually be seen in progress.

(4) The amount of erosion since the deposition of the clays has been very great, and while not accurately determinable, must have amounted to several hundreds of feet, if the indications found in the structure of the Navesink Highlands and other hills are to be relied on.

Finally, considering the facts above cited, it appears to the writer that a considerable amount, if not the greater part of the Pre-glacial Drift, may well have come from the erosion of Cretaceous gravel-beds. That these are the more resistant portions of disintegrated crystalline rocks is quite clearly shown. But the place of origin of the fossiliferous pebbles remains a mystery, and, it may be added, little more is known of the origin of the saccharoidal quartzite masses.

December 1, 1884.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Seventy-five persons present.

The Report of the Council, which recommended elections and payment of bills, was adopted.

The following persons were elected Resident Members:

MR. F. COPE WHITEHOUSE.
MR. J. F. KEMP.
MR. P. H. DUDLEY.
MR. GEORGE A. PLYMPTON.

A paper by Mr. GEORGE N. LAWRENCE was read by title:

DESCRIPTIONS OF SUPPOSED NEW SPECIES OF BIRDS OF THE FAMILIES TYRANNIDÆ, CYPSELIDÆ AND COLUMBIDÆ.

[Published in the ANNALS, Vol. iii., pp. 156-158.]

MRS. ERMINNIE A. SMITH read a paper on

THE IROQUOIS CUSTOMS AND LANGUAGE.

(Illustrated with Indian costumes and implements.)

[Published in the Journal of the Anthropological Institute, February, 1885.]

By request, COL. PARKER spoke upon the subject of the paper, and the PRESIDENT and others joined in the discussion.

December 8th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

DR. H. A. MOTT read a paper entitled:

AN INQUIRY INTO THE VALIDITY OF THE ORDINARY THEORY OF SOUND WAVES.

PROF. W. LE CONTE STEVENS, and others, discussed the paper.

December 15th, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

DR. J. S. NEWBERRY read a paper on

THE FOOD AND FIBRE PLANTS OF THE NORTH AMERICAN INDIANS.

(Illustrated with specimens.)

December 22d, 1884.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

DR. A. A. JULIEN described the glacial drift between New York City and Far Rockaway, L. I., and discussed especially the granitoid boulders scattered in front of the drift-hills of the terminal moraine.

This was followed by a discussion upon the pre-glacial and glacial drifts; upon the "fringe" in front of the terminal moraine; and upon the relative level of land and sea during the Glacial epoch, by PRESIDENT NEWBERRY, DR. JULIEN and PROF. FAIRCHILD.

January 5th, 1885.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

The Business was adjourned to January 12th.

MR. GEORGE F. KUNZ exhibited three diamonds from Cherokee Flats, Butte Co., Col.

The PRESIDENT exhibited photographs of the Columbia College Museum of Geology and Natural History.

A paper by PROF. H. CARRINGTON BOLTON was read by title,

A CATALOGUE OF CHEMICAL PERIODICALS.

(Published in the ANNALS, Vol. iii., pp. 159–216.)

PROF. CHARLES B. WARING read a paper on

EXPERIMENTAL STUDIES ON THE GYROSCOPE, GYROSTAT AND OTHER ROTATING BODIES.

The Gyroscope is a very curious instrument, or rather it is a simple little instrument which behaves in a very curious manner, apparently violating the law of gravitation.

It consists of a small disk, or wheel, moving freely on an axis which itself is supported by a ring going around the disk and axis both. On one side of the ring close by one end of the axis, is a small projection or lug. The wheel is set going like a top, by a string wound around one arm of the axis, and then pulled as fast as possible. The wheel revolves very rapidly, perhaps thirty times in a second. So far there is nothing strange, but if one takes the thing in his hands and tries to turn it, it seems to be suddenly endowed with remarkable powers of resistance. There seems to be something uncanny about it. If now, while yet rapidly rotating, the lug (in the under side of which, by the way, there is a small, round depression), be placed on a pointed standard, the instrument will keep itself out straight (horizontal) in the air and begin to revolve slowly around the point, always going in the direction of the under side of the disk. At the same time it drops very slowly —one-tenth of an inch or less in a second (more or less according to certain circumstances). It seems as if it had lost its weight, or as if gravity no longer acted on it, but if placed on scales while in this condition, it will be found to weigh exactly as much as when not moving.

If a string be attached to the lug, and the Gyroscope lifted off its support, it will go up into the air still at right angles to gravity, and still moving slowly horizontally around the end of the string. If it be jerked rapidly up, or dropped down, it continues its motion and position with the most perfect indifference. If another string be attached to the opposite end of the axis, and the thing be lifted by that, it will instantly begin to rotate (horizontally) in the opposite direction. Everything else will be as before.

It falls so very slowly, that this motion seems to be of no consequence, but if it can't fall just as it pleases, it gets the sulks, and falls as if dead; in fact it won't stay up at all. The horizontal motion also seems so small as if to be of no account, but if it can't do that it won't do anything, and down it falls at once. It is the most contrary piece of mechanism ever invented.

The two questions which most naturally arise when this instrument is exhibited are—first, why does it maintain the horizontal position? and, secondly, why does it revolve around the point of support?

There are many other questions which any explanation must meet and answer, but these are enough for the present purpose, and answering them really answers all.

Those who are familiar with the literature of the subject are aware that many attempts have been made to show why the Gyroscope acts in this manner. Some of the explanations are absurd, while others bring in the higher mathematics, and therefore can be understood by but few.

Some attribute the two effects largely to friction, but this explanation is disproved by the simple fact that the less the friction the better the instrument works. A writer in Appleton's Encyclopedia says that gravity acts with the motion of the disk on one side and against it on the other; *i. e.*, the side which is going downward is accelerated by gravity, while the other side, moving upward, is retarded. Thus there is a greater force on one side than on the other, and, of course, the Gyroscope is pushed around by the greater force. This is sufficiently disproved by placing the instrument so that it is free to move around its support horizontally, but not to fall any. It is found on trial that no matter how fast, or how slow, the disk revolves on its axis, there is no horizontal motion whatever. Without going any further in the explanations which have been offered, it is enough to say that the problems involved have been regarded as offering very considerable difficulty, and in all school works are passed over without any real solution.

The two questions which have been mentioned I shall endeavor to answer.

1st. Why, in apparent defiance of the law of gravitation, does the Gyroscope, when supported only at one end, remain in a horizontal position?

Before attempting an explanation, I ask that the following principles be admitted:

A body set in motion will continue in motion until something stops it. This is a part of Newton's first law of motion. Its best illustration for the present purpose is afforded by the pendulum. When the latter reaches the bottom of its arc it does not stop, but continues on its course up the opposite arc until the continued action of gravitation has produced a counter-force just equal to that caused by the fall, and then it stops. Again gravity draws it down, and again it rises. And so it goes on. Except for outside resistance, that from air and from friction, it could never cease that up and down movement. In the first part of its swing it accumulates energy, and in the other part spends it. The work and the energy for each vibration are equal.

Another principle equally important must also be remembered. A body moving in any direction is not retarded by a force exerted at right angles to its direction. The pendulum illustrates this also. The rod which holds up the weight pulls at right angles to the direction of the latter, but does not affect its velocity.

If these two principles are clearly grasped, the explanation of the Gyroscope is simple enough.

We will suppose the ring to be laid aside, since it serves no other purpose than a convenience for holding the disk, and that the disk (or wheel) is cut away until only a narrow strip is left, like two arms extending in opposite directions from the axle. No one who has a Gyroscope will wish to treat it in this manner, and as to conceiving such a thing most people find it too difficult, we will therefore change the Gyroscope for some thing cheaper and more simple, but which will enable us to show the working of the same principles. We will take a common T-square, or if we have none, we will nail a small strip of wood, say one inch square and ten inches long, at its middle on the end of another similar strip. This will make a T-square sufficient for our purpose. Now hold the stem of the square in the left hand close to the end, and make the cross-piece vertical. Hold the left hand still, and let the cross-piece move up or down. Evidently it will describe part of a circle. If it is held so that the cross is just in front of a plumb line, so that both can be viewed at once, it will be seen that the upper

end of the cross moves away from the plumb to the right, while the lower moves away from it also, but to the left. If, while the left hand remained stationary, the cross had been allowed to drop freely, the top and bottom would evidently acquire a certain horizontal motion, one to the right, the other to the left. If now the T-square be quickly turned over so that the top and bottom change places, this will not interfere with motion previously acquired; the bottom (which has now become the top) will continue to move to the left, while that which a moment before was the top will move to the right, and as the motion continues (as in case of a pendulum), the ends of the cross are pushed back to where they were, and the instrument rises to its first position. So long as this continues, the instrument will maintain its position, or at least it would if the change was instantaneous. As it is not, it falls slowly.

This answers the first question.

Secondly, why does the instrument rotate around the central point, in a direction always the opposite of that of the top of the disk?

Take the T-square again. Let it fall again a few inches. As in the first experiment, the top, when the T goes down, gets a motion towards the right—(if held as before)—but, before the instrument can be reversed, it must go half way, and point, instead of up and down, horizontally. Evidently the motion which sends the upper end to the right, will push the instrument (if the top was revolved towards the south), towards the north. Hence we have the horizontal motion.

Another question naturally suggests itself. Why, it may be asked, is the horizontal motion slow in proportion as that of the disk is rapid?

All depends upon the movement of the arms of the T. If this turns slowly, it has more time to give motion to the ends of its arms, consequently they push it around faster. If the T turns very quickly, it falls a very short distance (has so little time), hence the ends of the arms get very little motion, and, of course, can impart but little. Hence a quick motion of the disk makes a slow horizontal movement, and a slow motion of the disk makes a quick horizontal movement.

A careful consideration of the above will render it easy to see why the Gyroscope ceases to maintain itself if the lateral (or horizontal) motion is stopped, for in order to maintain

itself, the motion imparted to the ends of the T square, when vertical, must be expended in lifting; if spent in any other way, nothing is left to overcome gravity. Now if, as the square falls, and the T has become horizontal, some obstacle prevent its moving still further to the right, its motion in this direction would cease, and, of course, when it arrived at the lowest point, nothing would be left to lift the instrument.

Another paradox is that the instrument must fall some in order to produce any of its peculiar phenomena, but this, too, is easily explained. Everything depends upon the two extremities of the T getting a motion, one to the right and the other to the left, when the T is vertical. Now if the T does not fall, or if it is not lifted up, for either movement will do equally well, there will be no such motion; only if the first sends the instrument north, the other will send it south.

This directly or impliedly explains all the phenomena of the Gyroscope.

The paper was illustrated by apparatus, and discussed by PROF. W. LECONTE STEVENS and MR. FRANCIS COLLINGWOOD.

January 12th, 1885.

ADJOURNED BUSINESS MEETING.

Vice-President PROF. D. S. MARTIN in the chair.

Twenty-eight persons present.

The report of the Council, which recommended the appropriation of one hundred dollars for the Popular Lecture Course, and the election of nominees was adopted.

The following persons were elected Resident Members:

MR. E. H. TALBOTT, MRS. J. A. GALLAHER, MR. C. E. MUNSELL.

PROF. O. P. HUBBARD exhibited some "crows-feet," or Caltrops, found in cutting through an old fort in western Pennsylvania. The four points are barbed, in which they are unlike the figures in Webster's Dictionary and Rawlinson's Ancient

Monarchies, where the spikes are represented as plain, and inserted in an iron ball.

When the British evacuated Boston, they scattered great numbers of "crows-feet" on "the Neck" and in the streets.

At the battle of Arbela (B. C. 331), Darius Codomannus had them strewed over the ground in anticipation of an attack from the Greek Cavalry.

They were called *Tribolos* by the Greeks, and Tribulus by the Romans.

The Scots used them at the battle of Bannockburn, in the year 1314. They are not now employed.

MR. B. B. CHAMBERLIN read a paper, entitled:

NOTES ON MINERALS FROM THE FRENCH CREEK MINES, CHESTER CO., PENN.

(Illustrated with Specimens.)

The deposits of magnetic iron ore in the northern portion of Chester County, Pa., have attracted considerable attention from mineralogists, especially within the last two years.

The French Creek Mine, lately visited by the writer, is situated near the village of St. Peters, at the terminus of a branch of the Wilmington and Delaware Railroad.

The mine is located near the summit of a hill, over the slopes of which huge blocks of trap-rock are scattered in wild confusion. At this point, the Primitive and Triassic formations are in proximity, intersected by a narrow trap-dyke.

The first excavations were made for copper ore, but as little but the sulphuret of this mineral appeared, a new enterprise was inaugurated—that of mining for magnetic iron ore, which was found to exist in quantity warranting promise of great success. The supply has reached the amount of 15,000 tons per annum.

The mineral collector finds here ample supplies of the magnetic iron in octohedral crystals of a brilliant lustre. In combination with Pyrite and Chalcopyrite, the specimens are of much beauty.

The Pyrite presents the usual octohedral forms of splendent crystals, many of which are finely modified and are occasionally

of a size fully one or one-and-a-half inches in diameter. Their lustre is unusually permanent. They abound in veins of white Calcite, which add greatly to the beauty of the specimens.

Chalcopyrite is found in tetrahedral forms, with sunken or hopper-shaped faces. Many of the crystals exhibited a remarkable iridescence. The parallelism of grouped crystals is shown on an extensive scale.

Aplome Garnets are occasionally found; these are of a deep brownish-red color.

One of the most interesting minerals at this mine is *Byssolite*, a fibrous Hornblende as soft as silk. The color is a light olive green, inclining to a blue rather than yellow. It invests Calcite and other minerals with a thick coating, and also penetrates the Calcite, imparting to it a green hue of various degrees of depth.

By holding a bit of the Calcite against a strong light, the Byssolite fibres may be seen scattered in profusion in every direction. At other times the delicate fibres are scarcely to be detected by the unaided eye, yet the Calcite shows their presence by its color. Hydrochloric acid may be used to form cavities in the matrix when the Byssolite may be noticed projecting into the cavity, unharmed by the application of the acid.

Pyroxene occurs in small crystals, generally drusy, and grouped into stalactitic forms of much beauty. In color they are of a deep olive green, relieved by lighter shades.

Among other minerals found in the mine are a number of Zeolites, the most noticeable of which, perhaps, is Apophyllite, appearing in handsomely modified forms, not as showy, however, as specimens from Bergen Hill and Lake Superior.

An amorphous mineral, resembling at first sight red Orthoclose, is very abundant. Its nature has not yet been determined.

DR. A. A. JULIEN exhibited singular figures on Potsdam sandstones. He also remarked upon the boulders at Far Rockaway, Long Island, and their dispersion.

January 19th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty two persons present.

His Majesty, THE MAHARAJAH SOWINDHO MOKUN TAJORE, of Calcutta, Hindustan, was elected a Corresponding Member.

PROF. D. S. MARTIN exhibited a suite of Government Photographs of western scenery, and some water colors of scenery in Franz Joseph's Land.

The PRESIDENT related his experience on the Ives Colorado Exploring Expedition.

DR. A. A. JULIEN read a paper, on

GLACIAL OBSERVATIONS IN CANADA AND ON THE NORTHERN BORDERS OF THE STATE OF NEW YORK.

January 26th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Twenty-seven persons present.

MR. WILLIAM ELSEFFER read a paper, on

THE PLAN OF THE MISSISSIPPI RIVER COMMISSION, AND ITS RELATION TO NATURAL LAWS.

The paper was discussed by MR. COLLINGWOOD, MR. MCDONALD, and the PRESIDENT.

February 2d, 1885.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the chair.

The Report of the Council was adopted, which recommended the payment of a bill, and election of a nominee.

MR. WILLIAM L. ELSEFFER was elected a Resident Member.

PROF. EDWARD S. DANA, of Yale College, and PROF. PETER S. MICHIL, U. S. Military Academy, West Point, were elected Corresponding Members.

MR. W. GOOLD LEVISON read a paper, entitled,

NOTES ON THE TEMPERATURE OF INCANDESCENCE.

The PRESIDENT read a pamphlet report of new explorations

by Prof. Putnam in the "Mounds" of the Scioto and Miami Valleys.

February 9th, 1885.

STATED MEETING.

The Librarian, DR. A. A. JULIEN, in the chair.

Thirty persons present.

PROF. H. L. FAIRCHILD exhibited a specimen of Anthracite from Scranton, Penn., filled with flattened concretions. In the center of each concretion an exceedingly thin fibre of silicious matter. These are all arranged parallel with the deposit.

MR. P. H. DUDLEY showed the silicious fibres with the microscope by polarized light.

DR. A. A. JULIEN drew attention to the analogy between the concentration of thin, silicious matter in the coal and the formation of flint in chalk.

PROF. G. E. BAILEY read a paper, on

THE TIN DEPOSITS OF THE BLACK HILLS OF DAKOTA.

(Illustrated by ores, samples of tin, and photographs of the region and mines.)

February 16th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

A large audience present in the east lecture room of the Library Building, Columbia College.

MR. A. C. HAMLIN delivered the first lecture of the Popular Lecture Course, on the

MOSQUES OF CONSTANTINOPLE.

(Illustrated with lantern views.)

February 23d, 1885.

SIXTY-NINTH ANNUAL MEETING.

Held at the usual place of meeting, Hamilton Hall, Columbia College.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty persons present.

The Recording Secretary, PROF. O. P. HUBBARD, read a Report for the past year, which is summarized as follows:

There have been held nine meetings of the Council and thirty-two meetings of the Academy. The latter number includes five Popular Lectures. The average attendance of twenty-two meetings was forty-seven persons. The communications to the Academy number sixty, of which twenty-four were oral, and thirty-six were written. Most of them were illustrated. They are classified as follows: Mineralogy, 14; Geology, 13; Natural History, 8; Physics, 7; Arts, 7; Geography, 4; Engineering, 3; Chemistry, 2; Biology, 1; Mining, 1.

Four members have died, namely: Mr. A. J. Johnson, Mr. Charles Storrs, Dr. Louis Elsberg and Mr. Porter C. Bliss.

Eleven members have resigned, and sixteen new members have joined.

Through the liberality of the Trustees of Columbia College, the Academy has, for a year and one-half, occupied the Greek lecture room in Hamilton Hall free of expense, except the janitor's fees.

The Annual Election resulted in the election of the following officers for the coming year:

President: J. S. Newberry.
1st *Vice-President:* O. P. Hubbard.
2d *Vice-President:* W. P. Trowbridge.
Corresponding Secretary: A. R. Leeds.
Recording Secretary: H. L. Fairchild.

Treasurer: J. H. Hinton.

Librarian: A. A. Julien.

Councillors: G. N. Lawrence, J. J. Stevenson, C. Van Brunt, D. S. Martin, J. McDonald; A. A. Julien.

Curators: B. G. Amend, C. F. Cox, B. B. Chamberlin, N. L. Britton.

Finance Committee: Thos. Egleston, Henry Dudley, L. E. Chittenden.

The recent death of Dr. Louis Elsberg was the subject of eulogistic remarks by PROF. D. S. MARTIN, DR. J. S. NEWBERRY, and PROF. O. P. HUBBARD. Upon a vote of the Academy, the PRESIDENT appointed a Memorial Committee, consisting of PROF. D. S. MARTIN, PROF. O. P. HUBBARD and DR. A. A. JULIEN.

The matter of the future disposition of the Library was presented by the PRESIDENT, and it was discussed in its various aspects by several members. The President stated that the Trustees of the American Museum of Natural History desired to retain the Library, in anticipation of the enlargement of its building and increase of its facilities in other respects.

Mr. Melvil Dewey, chief Librarian of Columbia College, being present and speaking by request, said that the Trustees of Columbia College were considering the matter of offering to the Academy room and service for the Library in the Columbia College Library Building, free of expense to the Academy. He was himself an advocate of this arrangement.

The Academy voted to refer the whole matter to the Council with power.

March 2, 1885.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty persons present.

The Report of the Council was adopted, which recommended elections as follows:

MR. G. E. BAILEY and MR. WALTER H. LEWIS, JR., were elected Resident Members, and MR. CHARLES SLOSSON was elected a Corresponding Member.

PRESIDENT NEWBERRY exhibited calcite crystals enclosing copper, from Lake Superior. Also copper implements from the region of Lake Superior, resembling those from Europe. Also a rock specimen from Honduras, containing fragments of *Cycas*, probably of upper Triassic age.

MR. F. COPE WHITEHOUSE made remarks and read letters relating to question as to the origin of Fingal's Cave.

DR. A. A. JULIEN read a paper, on

METEOROLOGICAL AND HYPSOMETRICAL NOTES IN THE ISLANDS OF THE CURACOA GROUP, WEST INDIES.

March 9th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Ninety-seven persons present.

PRESIDENT NEWBERRY read a paper, entitled

THE ANCIENT CIVILIZATIONS OF AMERICA; THEIR ORIGIN AND ANTIQUITY.

(Abstract.)

When the white man landed on these shores, three hundred years ago, he found them covered with a dense forest, the home of the bear, deer, elk and the equally wild Indian. As the wave of civilization rolled westward, the forest was mowed down before it, and step by step the native tribes were driven deeper and deeper into their forest recesses. Behind the advance guard of the whites, the country was soon dotted with hamlets, which grew to towns and these in time to cities. The intervals between them were covered with grain fields and orchards, of which the growth was so luxuriant that it seemed

to prove the soil was now for the first time opened to the sunlight.

Thus several generations passed, and in time the invading hosts pressed through the great water-gap which connected the Hudson with the Lakes, or crossed the Alleghanies from Pennsylvania and Virginia, and took possession of the basin of the Ohio. Here, too, they found an unbroken forest, and the wandering and stealthy savage in full possession. Ultimately, however, he was compelled to yield to the superior number and intelligence of the whites, and within fifty years from the first struggle on the "dark and bloody ground" of Kentucky, he had practically abandoned all the territory east of the Mississippi.

When the forests were opened in this region, it was for the first time discovered that the nomadic Indians were not autochthonous, though commonly called aborigines, and that they had been preceded by a sedentary and partially civilized people, who had cultivated the soil, worked the mines and oil wells, and left behind them a series of monuments which are scattered over all the region lying between the Lakes and the Gulf. These monuments consisted of mounds, walls and other structures, composed of earth or rough stone, and among them the mounds (chiefly sepulchral) were so conspicuous that the people by whom they were constructed, for want of other designation, were called the *Mound Builders*.

The records of this ancient people (or peoples), with the lessons they teach in regard to their degree and kind of culture and their ethnical relations, will be referred to again.

Meantime we pass to notice a still more extensive and interesting series of monuments, which attest the ancient occupation of America by other and more civilized races.

Long before the whites had entered the Valley of the Mississippi and had discovered the first traces of the Mound Builders, the Spaniards had invaded Mexico and Peru, and found there a civilization in some respects superior to their own; a civilization which extended throughout Mexico, the Isthmus, and the west coast of South America to the frontiers of Chili; that had produced cities rivaling in extent and the magnificence of their buildings those of the Old World, cities that were lighted at night, guarded by police, that contained palaces, temples, courts of justice, schools of law, medicine and literature, with public gardens, aqueducts, fountains and artificial lakes.

The population was divided into casts which included royalty, nobility, different grades of traders and artisans, and finally slaves. Their countries were cultivated with much agricultural skill, and in the towns were workers in gold, copper and bronze. Their military organization was elaborate, and stragetic points were guarded by fortifications, some of which have had no rivals in magnitude in the history of the world.

This civilization, imposing as it was at the advent of the Spaniards, had passed its golden age, was then in its decadence, and has since, chiefly by the brute force, cruelty and rapacity of the European invaders, been nearly driven from the earth.

So much has been written of these two phases of ancient American civilization—that of the Mound Builders of the Mississippi Valley and that of the Palace Builders of Mexico, Central America and Peru—that no detailed description of them is required here. I shall limit myself, therefore, at this time to a brief review of some of the characteristics of these civilizations, particularly as bearing on the questions of their origin and date, questions just now much discussed and about which there is much difference of opinion.

THE MOUND BUILDERS.

It was for a long time believed that the ancient monuments found beneath the forests of the Mississippi Valley were all the work of one people, who, after long and general occupation of the country, had been completely exterminated by the more warlike nomadic Indians.

In opposition to this view it has been argued by many recent writers:

1.—That the so-called Mound Builders were not one, but many peoples or tribes.

2.—That in culture they are little in advance of the Indians.

3.—That their monuments were of comparatively modern date.

4.—That some of the various tribes found by the whites in the Mississippi Valley were their descendants and representatives

Without altogether denying these allegations, I venture to report some facts which, as it seems to me, must prevent the entire acceptance of these later views. These facts are:

1.—The number, magnitude, diversity and wide distribution of the ancient works, which cover the country from Lake

Superior to the Gulf, and from the Prairies on the west to the Alleghanies on the east. These prove the long occupation of the Mississippi Valley by a people or peoples, who were sedentary and agricultural, who had many fixed places of residence, and built towns of large size. It has been asserted that not less than ten thousand of these ancient monuments exist within the State of Ohio, and it is claimed with a show of probability, that the population which left these monuments was not only far greater than that of the Indians at the time of the advent of the whites, but that it was equal to the present population of the same area. For the accumulation of so great a population, the removal of the forest, the establishment of a system of cultivation which should provide means of subsistence, and the construction of even the monuments which now remain, must have required many centuries, and still other centuries must have elapsed in the gradual decay of this population and the return of the country to a state of nature.

2.—All the monuments were not only unoccupied, but had been so long abandoned that they were covered and concealed by a dense, mature and even venerable forest growth. Trees of the largest size and having an age of many hundred years were everywhere found growing on them, and the roots of these trees covered the decaying trunks of their immediate predecessors which died before they began to live. Harris, who in 1803 examined the earthworks at Marietta, states that the evidence was clear that two generations of forest trees, and perhaps many more, had grown upon these works since their abandonment; an interval of time that could not be less than a thousand years.

3.—The so-called Indians found by the whites inhabiting the Mississippi Valley, had no knowledge nor traditions of the builders of the monuments, and were in complete ignorance of the purposes for which they were constructed.

4.—The habits and mode of life of the modern Indian are very different from those of their predecessors, and if their descendants, they have greatly changed and degenerated. The ancient inhabitants of the country worked the copper mines of Lake Superior, rudely, it is true, but for a long period of time, and they had so thoroughly explored the country, that the traces of ancient mining were the chief guides in the subsequent operations of the whites. The mounds of debris piled

up by the ancient miners were of great size, and, like the earthworks of the Mississippi Valley, were covered with "primeval" forests when they were discovered by our people. The ancient inhabitants had oil wells in Canada, Ohio and Pennsylvania. They also worked the mica mines of the southern Alleghanies and at least one lead mine—that of Lexington, Kentucky; but these mines, like the mounds when discovered, had been abandoned for hundreds of years and were overgrown by forests, in which were trees that had obtained their maximum size.

All these facts seem to me to show that the so-called Mound Builders were people very different from the red Indian, and were far more advanced in the arts than even the most intelligent of the native tribes occupying the Valley of the Mississippi when the whites first entered it.

THE PALACE BUILDERS.

So much has been written of the monuments of ancient civilization found in Peru, Central America and Mexico, that any detailed description of them would be quite superfluous here.

Suffice it to say, that from the frontiers of Chili to Salt Lake, in Utah, an almost uninterrupted succession of ruins may be said to exist. These consist of abandoned towns, fortresses, palaces, temples, pyramids and other monuments which are built of stone, and though differing much in detail, have a certain general resemblance throughout; so that we may fairly conclude that they are the relics of different tribes or nationalities which were of common stock, or, at least, derived their civilization from a common source.

Of the people who constructed these monuments we are not left in ignorance so complete as that which overshadows the work of the Mound Builders, since in Peru, Central America and Mexico the Spaniards found the descendants of those who had constructed the monuments in the practice of their arts, and in the observance of their customs in politics and religion. Also in our own country are a few scattered towns, inhabited by the descendants of the population which once so completely covered the country they inhabit, where we can see to-day, at least a provincial phase of the civilization which once extended over all the western side of North and South America, within the limits mentioned above. But at the time of the Spanish conquest, the civilization of the ancient in-

habitants of Mexico and Central America, and probably of Peru, had already long been in decadence. This is attested by many facts. Within our own territory, the progenitors of the inhabitants of the Pueblo towns—the Moquis, the Zuñis, etc., —were once so numerous, that they seem to have cultivated every inch of arable soil. Around every spring and along every stream their stone-built structures, all in ruins, may be seen, and we have everywhere evidence in their cliff dwellings and fortresses that they maintained a constant defensive warfare against numerous and warlike enemies. These enemies seem finally to have prevailed and to have driven off or destroyed the peaceful agricultural population, except where their towns were perched on high and inaccessible rocks, where the natural defenses of their position afforded a protection that their own courage and prowess did not furnish.

Accepting the almost inevitable conclusion that the peculiar and similar monuments which are scattered over Mexico, Central America and Peru, are the work of related nations who drew their civilization from a common source, we must admit that for the development of this civilization and for its spread to Chili and Utah, ages must have been required; still other ages must have passed in its periods of prosperity and decline. That decline began many hundreds of years ago, for I have myself seen towns on the table-lands of our southwestern territories, where even in that dry climate the cedar wood that had been used in their construction, had completely disappeared by decay; a result that could only have been reached if they were abandoned long before the advent of the Spaniards.

Hence, in my judgment, those who have attempted to bring all the history of this western civilization, with its necessary phases of growth, prosperity and decay within a thousand or even two thousand years have been in error, and I am constrained to believe that some of the ancient monuments of the Mississippi Valley, as well as those of Western America, may claim an antiquity equal to that of the oldest known civilizations of the Eastern Hemisphere.

Of the origin of the ancient civilization of America, I will only say that in my opinion it was indigenous. The culture of the Mound Builders, rude as it was, evidently owed nothing to a foreign source. Though they were ignorant of the methods of smelting iron from ore, they worked the mines of copper

and mica with persistent though unskilled industry, and wrought copper, silver, and, as Putnam has shown, meteoric iron, with commendable skill. We have no proof that any of these metals were melted and cast, an art which they would certainly have acquired if they had been in communication with the Old World.

The civilizations of Mexico, Central America and Peru were much higher, the use of iron was apparently unknown, but the smelting of other metals was understood, such as the union of tin and copper to make bronze. They also practised the fusion of gold and silver, the combination of copper and gold, and the process known among jewelers as pickling—that is, dissolv-solving the copper from the surface of an alloy of gold and copper, and burnishing the gold to make it appear like a pure and solid mass. And yet we fail to find proof that they borrowed anything from other civilizations. As workers of stone they had no superiors, their carving was elaborate and peculiar. When we search elsewhere for similar work, we find nothing like it in the style of building or architectural decoration in any of the monuments of Egypt, Assyria, Greece or Rome. We do find, however, a marked similarity between the decorative ideas of the inhabitants of Central America as expressed in their monuments and those of the Indians of the northwestern coast with their multitudinous carvings in stone and wood, the decorations of their canoes and totem posts. Also with the characteristic carvings of the inhabitants of the Pacific Islands.

Hence I am inclined to believe, as has been suggested, by Baldwin, that the seeds of this ancient civilization were brought from the East Indian Archipelago, from island to island across the Pacific, and that finally reaching our continent, and prevented by the great and continuous chain of the Cordilleras from further eastward migration, it slowly spread southward to Chili and northward to our western Territories.

March 16th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

A large audience assembled in the east lecture room of the Library Building, Columbia College.

The second lecture of the Popular Lecture Course was delivered by CAPT. E. C. DUTTON, on

VOLCANIC PHENOMENA.

March 23d, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty-five persons present.

PROF. PERSIFOR FRASER was elected a Corresponding Member.

PRESIDENT NEWBERRY called attention to the "Bill for the Preservation of the Falls of Niagara," pending in the Legislature of the State of New York. On motion of PROF. D. S. MARTIN a committee was appointed by the President to draft resolutions expressive of the opinion of the Academy on this matter. At the close of the meeting this committee reported as follows, and the report was unanimously adopted:

Whereas, The Falls of Niagara are justly regarded as forming one of the glories of our country and our State, both in respect to the grandeur of their scenery and to their great scientific interest as a display of the action of natural forces; and

Whereas, The bill for the securing of the adjacent property is now pending before the Legislature of the State, and the whole work done by the commission will be lost and a priceless opportunity thereby suffered to pass if the proper provision is not made now for its consummation; therefore

Resolved, That the preservation of the Falls of Niagara and the surrounding scenery against all forms of injury and spoliation, and all absorption by monopolies, is a matter of the highest interest and importance to the people of this State through all coming generations; and

Resolved, That the NEW YORK ACADEMY OF SCIENCES would earnestly urge upon the representatives of the people at Albany, the prompt adoption of the measures now pending for the permanent reservation of the "Niagara Park."

D. S. MARTIN,
W. P. TROWBRIDGE,
F. COLLINGWOOD,
} *Committee.*

DR. NEWBERRY then read the following paper, on

SOME RECENT DISCOVERIES OF ROCK-SALT IN WESTERN NEW YORK.

Rock-salt has been struck in a number of places in the upper valley of the Genesee, and preparations are now making to work the salt beds. The limits of this salt field have not been determined, and it would not be at all surprising if the announced discovery at East Aurora should be confirmed, and the salt deposits be found to extend continuously to and perhaps beyond this point, which is not more than fifty miles distant from the Genesee salt wells. It will thus be seen that the discovery at East Aurora is principally important as indicating a greater extension of the salt field of western New York than was before known. It is even possible that the area of this field is really much greater than has been imagined, for the salt deposits of the Genesee Valley may extend east as well as west, and they may even reach to connect with those recently discovered by boring near the Pennsylvania line south of Syracuse.

All the salt deposits of New York apparently occur in one formation, that which has been called for that reason the Onondaga Salt Group, or more recently, the Salina formation, a part of the Upper Silurian system. This seems to be the deposit of a great salt lake which occupies Central and Western New York, Northern Pennsylvania, Northeastern Ohio, and Southern Ontario. Its outlines are not yet definitely traced, and may have been quite irregular, but probably include an area as great as that of Lake Huron or, perhaps, Lake Superior. In this lake, beside the land-wash, which is now represented by the colored shales and marls seen about Syracuse, were deposited great sheets of gypsum and rock salt, and when the water surface was more extended, the impure limestones which form the well-known "Water Lime Group," from which so much hydraulic cement is made on the Hudson and in Central and Western New York. About Goderich, Canada, near the northern margin of the old salt lake, rock salt has been found in a number of wells, forming beds two to sixty-five feet in thickness interstratified with gypsum and water lime. At Sandusky, Ohio, near the western border of the old lake, where its sediments are not more than forty feet in thickness they include beds of gypsum which are the basis of an important industry. At Syracuse the salt is not obtained directly from the Salina formation

but from brine pumped from wells which penetrate a great mass of sand, gravel, etc., that fills one of the old buried channels formed when the continent stood higher above the ocean than now—before the Ice Period, when they were to a large extent filled and obliterated—and its surface was deeply scored along the lines of drainage. The old channel at Salina, cutting across the strata, receives the drainage from deeply buried beds of salt, long ago suspected to exist, which have lately been discovered by borings into the country south. Salt being very soluble, rain falling on the surface and penetrating the rocks to these beds of salt has gradually dissolved them to form brine, which flowing down to a lower level, has filled the reservoir formed by the old channel referred to, and from this has been pumped up and evaporated.

The salt deposits of the Salina Group exhibit an interesting diversity of composition. Some are almost chemically pure, while others contain a large quantity of chloride of calcium, chloride of magnesium, sulphate of magnesia, etc., which constitute the "bitterns" of the salt boilers. These differences are apparently the result of different conditions under which the precipitates were made. Salt water contains a great variety of substances held in solution, among which gypsum, common salt, sulphate of soda, sulphate of magnesia and the chlorides mentioned are most abundant. When it is evaporated these salts are thrown down in the inverse order of their solubilities. For example, the sulphate of lime (gypsum) being the least soluble, is first deposited; then when the solution is more concentrated, chloride of sodium and the other salts in order, until finally only the deliquescent salts mentionad are left. These have such affinity for water that they do not exist in nature except in solution, and after being artificially prepared rapidly absorb moisture from the atmosphere. These facts give us an explanation of the varying purity of the salt, and the occurrence in certain places of great sheets of gypsum. Where a land-locked basin receives the drainage from the surrounding country—which, though apparently pure water, always contains some salts—by evaporation the water becomes "salt"; a characteristic of all undrained lakes; Great Salt Lake and the Dead Sea being good examples. If such a solution should be further concentrated, the least soluble ingredient, gypsum, would be first thrown down; and a sheet of this might be precipitated while yet

all the other saline constituents were held in solution. With further evaporation a belt or margin of gypsum would be left around the shallower portion of the lake, and chemically pure salt would be deposited when the concentration passed the point of saturation for salt. The diminished waters now retiring to the deeper parts of the basin would leave behind them in places sheets of pure salt, while the precipitates subsequently made would contain an abnormal quantity of bitterns.

Just such a record we seem to have in the sediments of the old Salina lake as well as those of later date in other parts of the world; the salt of certain localities or certain layers being nearly pure, while that of other localities or layers contains an undue proportion of impurities. The salt basins of the Upper Ohio and of Michigan, both distinct from and of later age than that we have been considering, show the same peculiarities.

By some writers the gypsum of the Salina Group, as well as that of other formations, is attributed to the action of acid waters on carbonate of lime, but the continuous sheets of gypsum contained in the Salina Group, separated by thin bands of pure limestone, disprove this theory. They are evidently chemical precipitates from saline waters, alternating with the limestones, which were formed from the hard parts of organisms inhabiting the water during the intervals when it was pure enough to sustain animal life.

Dr. Arthur H. Elliot read a paper on

SANDSTONES USED FOR BUILDING PURPOSES IN NEW YORK CITY.

(Illustrated by specimens and tables of analyses).

The subject was discussed by Dr. Julien, Mr. Collingwood and the President.

March 30th, 1885.

Stated Meeting.

The President, Dr. J. S. Newberry, in the chair.

Thirty-one persons present.

Mr. B. B. Chamberlin exhibited a fine specimen of black tourmaline from Russell, St. Lawrence Co., N. Y.

PROF. W. P. TROWBRIDGE read a paper

ON THE TRIGONOMETRIC AND TOPOGRAPHIC SURVEYS OF THE UNITED STATES.

(Illustrated with lantern views, and instruments employed in the field).

PROF. J. K. REES exhibited and described the instruments used in geodetic work by the students in Geodesy in Columbia College.

April 6th, 1885.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the chair.

Forty-five persons present.

The report of the Council was adopted which recommended the payment of bills and the following election: MR CHARLES P. BONNETT as a Resident Member. MR. BONNETT was unanimously elected.

DR. O. P. HUBBARD remarked upon the Sargasso Sea, of the central Atlantic Ocean, and exhibited a fresh specimen of the Gulf weed (*Sargassum bacciferum*). He alluded to the golden yellow color of the floating masses, and to similar accumulations of Algæ in the South Indian and Pacific Oceans.

The PRESIDENT referred to the climatic conditions governing the accumulation of these masses, the regions being areas of calms; and to the great amount of animal life existing upon the Algæ.

MR. GEORGE F. KUNZ read a paper

ON THE MINING AND CUTTING OF GEMS.

(Illustrated with lantern views).

The subject was discussed by MR. COLLINGWOOD, DR. HUBBARD, DR. ELLIOT and the PRESIDENT.

April 13th, 1885.

Stated Meeting.

The President, Dr. J. S. Newberry, in the chair.

Forty-two persons present.

Mr. Geo. F. Kunz exhibited a Ceylonese zircon of 6½ karats weight, penetrated its full length by three crystals of acicular rutile, also a pearl found in a common oyster, *Ostrea borealis*, from the Shrewsbury river. This pearl bore a striking resemblance in appearance to a small human eye, measuring over ⅝ inch (17 mm.) across, the part representing the pupil being dark green and gradually shading into pure white. It was said to be the largest pearl of this variety yet observed. That portion of the surface which was of a white color had the characteristic wavy radiated reflection usually observed in pearls from the common conch, *Strombus gigas*. Like all other pearls from the common oyster it lacked the beauty and lustre requisite to a commercial value. Mr. Kunz also showed a diamond of the form described by him in *Science* of May 30, 1884, made up of a multiplicity of twinnings, called also "extreme durate" by the French. It had been cut into the rude outline form of a brilliant, and its table had been placed on a diamond polishing wheel for 100 days. The average circumference of that part of the wheel on which it was placed being about 2½ feet, and the wheel going at the rate of 2,800 revolutions per minute, the surface that traveled over the diamond table amounting to over 75,000 miles. At times, four to eight pounds were added to the usual two and one-quarter to two and one-half pounds of the clamp or holder, and for a time forty pounds extra were added, this last causing the wheel to throw out scintilations for several feet. The diamond fairly ploughed the wheel, practically ruining it, so that it required planing before it could be further used. No polish was produced, however, sufficient to give the brilliancy necessary in any diamond gem. These experiments

were conducted by MESSRS. TIFFANY & Co., who were also the owners of the diamond.

DR. CHARLES E. MOLDENKE then read the following paper:

THE LANGUAGE OF THE ANCIENT EGYPTIANS AND ITS MONUMENTAL RECORDS.

(Illustrated with lantern slides, papyri, etc.)

The importance of the study of Oriental languages is being gradually recognized in our country, and some of our prominent universities have begun to give instruction in a few of these languages. Of all Oriental languages, however, that of Ancient Egypt claims our chief attention, for all of them, whether Arabic, or Hebrew, or Assyrian, are merely secondary sources from which we derive our knowledge of the most ancient world. They must continually fall back on the Egyptian, from which most of them have received even their alphabet. The great interest manifested everywhere in the customs and manners, as well as the language, of the ancient inhabitants of Egypt, is therefore, a just tribute to and a worthy acknowledgment of the preëminence of that strange people above all other nations of former days. No one can peruse the story of the legendary lore of Egypt, hear the majestic odes addressed to the Deity, or scan the vast realm of research which opens to his view, without expressing a wish to be able to read the curious writing of that people himself in the original. That this is not so impossible as it may appear at first sight, is attested by the imposing array of Egyptologists all over the world. Still even with regard to this some popular fallacies have remained up to the present day. It was customary formerly, and is customary even to some extent nowadays, to designate as *mysterious* whatever bears the name of Ancient Egypt, and, of course, to stigmatize the language itself a labyrinth of mysteries. Such views, however, expressed at the present time, would lead us back into long forgotten days when ignorance was bliss.

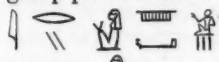
In the annals of philological research we seek in vain for a study that can lay juster claim to a first position, for any that has made more rapid and important progress in a short time than that of the Ancient Egyptian language. It was reserved to our century to solve the mystery of a language that had for more than one thousand years baffled the ingenuity and most searching inquiry of great men and scholars. Fifty years ago still witnessed the first beginnings of a science struggling for existence amid a chaos of opinions, while leaning for support on an unpretending black stone bearing a trilingual inscription. Yet this weak support was destined afterwards to become the very foundation of this study, and the discovery of this stone at Rosetta in 1799 inaugurated a new era in archæological research and scientific investigation. Many years of labor passed before the correct alphabet was determined and then, with the help of Italian scholars, the Coptic was resuscitated from the darkness that was gathering around it, being then at the brink of utter decay. The Egyptian words were then carefully compared with the Coptic, and at last the meaning of words determined irrespective of the Greek translation of the Rosetta Stone, whose version was nevertheless fully corroborated. To one man above all belongs the honor of having watched over the early stages of the study with a jealous and loving eye, the illustrious founder of the science of Egyptology, *François Champollion* (1791–1832). At the time of his death the study had made a most remarkable progress and found worthy successors to build up the mighty structure we have now. To another man, *Richard Lepsius* (1810–1884), one of the greatest scholars and profoundest thinkers of this century, we owe the critical examination of Champollion's system and the gradual consummation of the work in its present form. His incessant labors have given to the study of Egyptian its prominent position in philology, in literature, in history, in the arts and exact sciences. Through him the knowledge gained of ancient Egypt has been treasured up in the books of scholars, has elicit-

ed the unbounded praise of all nations, has increased our knowledge of history, has furnished weapons against the adverse criticism of the Bible, and has insured to the study of Egyptian a permanent place in the leading universities of the world. He lived to see the time that the Stone of Tanis (otherwise called the Decree of Canopus), discovered by himself, proved beyond the shadow of a doubt the truth of his teachings and of his whole system of interpretation. Since then every voice of opposition has been silenced. As can readily be inferred, he has not done all this work by himself, but had a host of willing laborers, whose names form around him a halo of surpassing lustre. Suffice it to recall such names as Brugsch, Ebers, Duemichen, men before whom science bows in homage, or such as Birch (England), Pleyte (Holland), Rougé, Chabas and Maspero (France). A host of admirers of Egyptology is pressing on in the wake of these scholars, and adds fame to the laurels already gained by them. "Progress" is the watchword of Egyptology, nor need we be surprised at this, as we must bear in mind that thousands of monuments still remain buried away under the sand of the desert and the soil of the Nile-valley and that each addition to the discovered inscriptions helps to fill up some little gap that appears in various parts of this young study.

The language of the ancient Egyptians, spoken for certainly more than 4,000 years, till it ceased about two centuries ago, was an intermediate form between the Shemitic and Hamitic languages, and was in use from the Mediterranean Sea to the land of Ethiopia or Nubia. It was written at first not by conventional signs or letters, but by actual pictures of visible objects, called hieroglyphs (*i. e.* sacred carvings). This method of writing a language leads us to believe Egyptian to be the oldest of all written languages. As in the case of our aboriginals here, we would expect the first beginnings of a written language to be a disconnected enumeration of ideographs without any phonetic values affixed to them. This is, however, not

the case with the Egyptian language as we know it now, for the very first inscriptions show the same method of writing employed about 2,000 years later under Thothmes III (1600 B. C.) and Ramses II (1200 B. C.) This points undoubtedly to a long period of development before it was possible to obtain such a splendid system of writing as elicited the praise of men at the time of the lawgiver Moses. It is, therefore, much to be regretted in the interest of philology and of the difficult question on the origin of language, that we possess no earlier inscription than that of the second dynasty of King Send (about 4500 B. C.), now at Oxford. It leads us immediately into the labyrinth of the two interchangeable methods of writing employed by the Egyptian scribes. We find it composed of:

First: IDEOGRAPHS, which represent either (A) the *object* or (B) the *word*.

(A) When used to represent objects, these ideographs are *determinatives* to fix the meaning of a group of hieroglyphs which precedes, but are *not* pronounced. Thus in the word the last two characters are mute. The last shows that the group preceding represents a 'tree,' the third sign shows that the fruit of this tree grows in 'pods,' the whole group pronounced *âsh* means "acacia-tree." In the word  we find the seven last characters mute; the first is the symbol of "guardian," the second is a "door," the third a sign of "action," the fourth a "man," who 'does' the 'action' of 'guarding' the 'door,' the last three show that there is more than one hence the whole word is "doorkeepers" or "watchmen," and is pronounced *ari* . Other words whose signification can be

readily understood from the determinative are: *rem* "fish," *reth* "man," *himt* "woman," *hehui* "the two ears," *mes* "to beget," *texen* "obelisk," *menfi* "soldier."

(B) When used to represent words, these ideographs may represent the object and be pronounced at the same time. Thus *râ* "the sun," may also be written in full , *qa* "bull," also in full; *ta* "the earth," *mu* "water," *ab* "heart," *per* "house," *men* or *set*, "country," are generally written without any accompanying phonetics, but always pronounced when not serving as determinatives of a preceding word. Pure ideographs, that is such as represent the figure and yet cannot be pronounced, do not occur in any Egyptian inscriptions.

Secondly: PHONETICS which are either (A) *letters* of the alphabet, or (B) *syllables*.

(A) The simple letters of the Egyptian alphabet are:

1. a. 2. â. 3. a. 4. i. 5. ì. 6. u. u. 7. û. 8. b. 9. p. 10. f. 11. m m. 12. n n n. 13. r. 14. l. 15. h. 16. h. 17. x (the Greek chi). 18. s s. 19. sh. 20. sh. 21. q. 22. k. 23. g. 24. t. 25. th th. 26. d. 27. z. 28. z. z. [The letters not numbered are only *variants* of the preceding.]

(B) The greater number of the 3,000 to 4,000 Egyptian

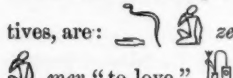
characters represent syllables; thus n-t-r (pronounced nuter) "god," n-f-r (nefer) "good," s-t-n (suten) "king," n-z-m (nezem) "sweet," h-s (hes) "sing," û-r (ûr) "great," n-n (nen) "not," q-a (qa) "carry," q-m (qem) "find," q-m-a (qema) "create," s-b-k (sebek) "crocodile," n-f (nef) "wind". These may also be written in full with the letters of the alphabet and proper determinatives.

The use of *phonetics* was, in one way, of the utmost importance to the scribe in distinguishing signs that could have different pronunciations; thus the ★ has two pronunciations *seb* and *dûa*. The star ★ itself would begin the word in ★ . The second character being a *b*, the star can only have the pronunciation *seb* "a wall," in ★ the second character is û, hence ★ is here *dûa* "adoration." and are here complements of ★.

The *determinatives* were important in distinguishing between *homonyms*. Our language is rich in words, having the same pronunciation, which we distinguish either by different spelling (right, rite, wright, write) or by the sense (right—opposed to left, right—correct). The Egyptian language was very poor in verbal roots, and used the same arrangement of consonants or vowels for between two to twenty different words, whose meaning was only changed by the determinatives; thus verbal root â-n-x changes meaning according to the determinative: "to live," "an ear," "to swear,"

"food," "a flower," "a star," "a door," all pronounced alike. Also "a fish," "to weep," both pronounced *rem*; "a leopard," "the god of the toilet," "to depart," "an image," "a flame," "a vessel for holding ointment," all pronounced *bes*.

Some other examples to point out the force of the determinatives, are: *zed* "to speak," *a* "ah! oh!" *mer* "to love," *ân* "a scribe," (the first character representing the reed, inkstand, ruler and paint-box), *ân* "to see," *ad* "dew," *kek* "night," *ûrît* "chariot," *usex* "boat," *máxa* "balance," *beb* "bracelet of gold," *nub* "gold."

While the Egyptian language was not changed in the least, still in Ptolemaic times we find a peculiar orthography brought about by inventing signs of a very fantastic character (such as ), by giving some characters different pronunciations, and above all by making plentiful use of ideographs (with pronunciation!). A description of the interpretation of such texts, which are very difficult to solve, would require too much space. One example may suffice.

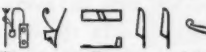
Plutarch tells us in his book "Concerning Isis and Osiris" chapter 36, that on the temple of Athene (*i. e.* the Egyptian Neith) in Sais, there were five hieroglyphic figures: a child, an old man, a hawk, a fish, and a hippopotamus, which he was told meant "Oh ye who come into existence, and ye who pass away, God abominates wickedness," which must have been written or *renpu auiu Hor betu tep*, and must be translated: "Ye who are young and ye who are old, God (or Horus) hates iniquity," thus corroborating Plutarch's statement. Prof. Dr. *Johannes Duemichen* of Strassburg, Alsace, the writer's friend and teacher, has done most to further the study of such difficult and abstruse texts.

All that has been said above refers to the first kind of Egyptian writing called HIEROGLYPHIC, which the stone of Rosetta renders *sexi-en-nuter-zedu*, literally: "writing of sacred words." A second division is the HIERATIC, which differs from the one just spoken of only in the mode of writing, while the words remain wholly unchanged. It is a less defined and more cursive form of Hieroglyphic, and has the advantage of employing only about 500 characters to express all Egyptian words. The Egyptians noticed at an early time that the papyrus with its many fibres would not permit the writing of signs with such precision as on stone, and therefore they invented this more convenient method of drawing the pictures in outline with a thick pencil, as at present the Arabs and Persians write their books with a "*Kalam*" or Latin stylus. The origin of this writing, as far as we are able to determine now, can be traced back as far as the fourth dynasty, for in the Pyramid of Gizeh we find the name of Cheops, the Egyptian Chufu (about 3733 B. C.), written in a style closely resembling the later Hieratic. This writing of the transition period was retained in copies of the "Book of the Dead," while for secular purposes the continued simplification of the

signs resulted in the pure Hieratic. In order to show the similarity between some of the Hieratic and Hieroglyphic figures, both are added:

This Hieratic writing was used principally for state documents, medical and geometrical treatises, letters, hymns and stories. As we write in English each a different hand, so every Egyptian scribe had a peculiar chirography of his own, which

furnishes the only difficulty in deciphering texts of this kind. Another point that deserves particular attention is that whereas the Hieroglyphic can run from left to right or vice versa, the Hieratic and Demotic can be written from right to left only (cf. above), whence all Shemitic languages are written in this way.

The third kind of Egyptian writing, the DEMOTIC called  sexi-en-shâi, or "writing of letters" in the Rosetta Stone, which originated about 700 B. C., is even more cursive than the Hieratic, and looks much like short-hand Egyptian. We find many inscriptions, both legendary and funeral, of the latest period written in this style, though it was used most frequently for contracts and the most secular purposes.

These three methods of writing, however, were soon obliterated when Greek influence began to be felt in Egypt. COPTIC took the place of them all in the fifth century of our era. The Greek alphabet was substituted for all Egyptian letters, except seven which were retained for sounds not existing in the Greek language. To this Coptic we are altogether indebted for our translations of Egyptian inscriptions, for, strange as it may appear, the Egyptian language in the thousands of years of its existence had hardly undergone any material changes. The relation may be expressed thus—Coptic : Hieroglyphic, Hieratic and Demotic : : Modern English : English of Chaucer's and Spenser's time.

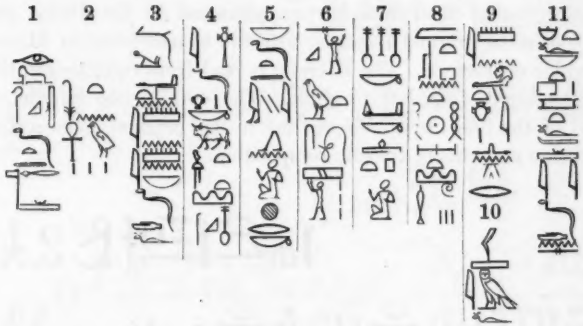
As far as the grammatical analysis of texts of various periods is concerned that of the oldest time presents the most difficulties. The sentences are very concise and the words pregnant with meaning, while many odd and antique idiomatical expressions meet the eye everywhere. The time between Thothmes III and Ramses II (1600-1200 B. C.,) the golden period of Egyptian history, represents Egyptian literature in its highest state of perfection. Of that period we possess the most monuments. The style of writing had broadened considerably, long

sentences, with all that they include in our present usage, and many rhetorical figures appear in the Hieroglyphic, while the Hieratic and Demotic present the easy and graceful style of our modern languages. Foremost among writers of that period were Enna, Qagabu and the poet Pentaûr, the Homer of Egyptian poetry.

While the museums of the Old World are rich in monuments and hold the key to the history of Egypt, only those in our country call for a remark in this paper. New York of course holds first rank, with its obelisk in Central Park and the excellent collection at the Metropolitan Museum of Art. Most of the objects in the Museum have to do with the dead, for instance: the mummies, the canopic vases surmounted by the head of an animal, man or bird and containing the bowels of the deceased, the small charms placed inside the mummy case, the small brown, bluish or green statuettes in the form of a mummy, called ushabti, symbolical representations of the person to whom they were given and bearing his name, small funeral stele, bricks of the time of Thothmes III. and many other objects quite impossible to enumerate here. Then there is in New York the famous Abbott collection, (the largest in the country, surpassing in many respects some European collections,) at the New York Historical Society, and the collection of Columbia College. Johns Hopkins University possesses some fine specimens of statuettes, scarabæi, precious rings of later dynasties and a few excellent stele. Lafayette College has the important Papyrus Gen. Stone, while Boston and Chicago boast of no small collections. Besides these there are thousands of Egyptian monuments scattered over our country, which are for the most part in private hands, and are unfortunately only occasionally heard of by Egyptologists.

I add an inscription on the following page to serve as specimen of an Egyptian stele (published for the first time!).

FROM THE METROPOLITAN MUSEUM OF ART, NEW YORK CITY.



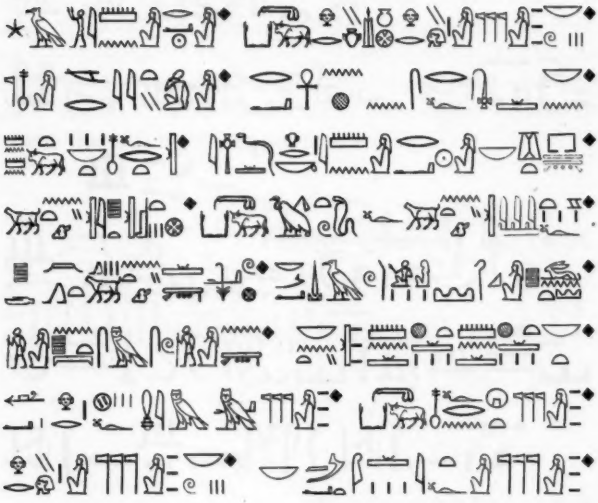
Lines 1 and 2 read in the original from right to left! Below lines 1 and 2 the god Osiris is represented as sitting on his throne, and the inscription of these two lines refers to him. Below lines 8 and 9 we find Amen-neb, the dedicator of the tablet, kneeling, and below line 11 his wife Hûi kneels.

Transcription: (1) Usar heq zeta nuter â (2) suten ânxu (3) mer ârât en Amen Amen-neb zedef (4) anez hirek qa amenti heq nefer (5) neb zeta iu ena xerek (6) seka-ut sûshu (7) nefer-uk duk hotepa (8) em ast ent neheh set hesu (9) amen hâti-a nen ger (10) amef (11) himtef nebt per mertef Huî zed nes.

Translation: (1) [This is] Osiris, the god of eternity, the great god, (2) The King of the living. (3) The chief of the store-house of Amen, Amen-neb says: (4) Hail to thee, ruler [literally: 'bull'] of the Lower World, gracious god, (5) lord of eternity, let me come before thee, (6) let me extol in praise (7) thy beauty. Give me peace (8) in the abode of eternity, in the country of praise [i. e. Hades] (9) that will hide my heart. There is no de- (10) ceit in it [i. e. the heart]. (11) His wife, mistress of his house, his beloved, Huî, she [also] repeats [this prayer].

The first five lines of a Papyrus (containing 75 lines), being the beginning of an ancient hymn addressed to the Deity, are added in the original Hieratic, with the transcription in Hieroglyphic characters. The Hieratic is read from right to left, the Hieroglyphic from left to right. The dots in the middle or end of the lines, written in red ink in the original manuscript, indicate that this is a poetic composition.

Hieroglyphic Transcription:



A free Translation of the above.

Praise ye Amen-Râ,—the mighty one who dwells in Heliopolis, great above all the gods!—A gracious god is he to those who love him.—His rays of life enlighten—All his grand creation.—Hail to thee, oh Amen-Râ, whose seat is Egypt's double throne!—Thou art the prince in Southern Thebes,—Grand sovereign in thy realm.—Thou goest through the Southern land,—And nations call thee lord. Arabia calls thee prince.—Thou Ancient One of Heaven, and Oldest One of Earth,—Who didst produce existences and govern things, doest still support creation.—Thou art unchangeable amid the changes of the gods.—Thou art benign, a ruler of the heavenly cycle,—Yea, lord of all the deities,—The prince of truth and sire of the gods.

April 20th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

A large audience assembled in the east lecture-room of the Library Building, Columbia College.

The third lecture of the Popular Lecture Course was delivered by PROF. D. CADY EATON. Subject:

CANTERBURY CATHEDRAL.

(Illustrated with lantern views.)

April 27th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty persons present.

MR. JAMES F. KEMP exhibited a collection of fossil plants made by MR. J. H. PERRY, in the vicinity of Worcester, Mass., and remarked on them as follows:

In the *American Journal of Science* for February, 1885, were published some notes on a *Lepidodendron* found in the graphitic coal mine near Worcester, by Mr. J. H. Perry, and it was thought that perhaps the long-looked-for fossil of these metamorphic rocks had been found to establish their character. On the table are some specimens, kindly sent by Mr. Perry, consisting of two specimens of *Sigillaria*, a *Lepidodendron*, and some indeterminate vegetable remains. There is also a series of chips from the enclosing rocks of the coal mine, and also another series from the neighboring hydromica slate and associated mica schists. The resemblance at first sight between the graphitic schists and the hydromica slate or phyllite is very close, and they appear, indeed, to be identical. Stratigraphically, however, they strike at exactly right angles to each other, the graphitic schist (?) running N. W. and S. E., the phyllite N. E. and S. W., parallel to the general strike of the metamorphic rocks in this vicinity.

Mr. Perry inferred that this opposition in strike might have been occasioned by the protrusion of a granite boss that projects near by, but his studies have not developed this point to a certainty. It would seem that the graphitic coal bed is a northerly prolongation of the Rhode Island coal basin even more highly metamorphosed than it, but that the other series—the hydromica slate, or phyllite or ottrelite—is of the metamorphic rocks as we know them in this vicinity and to the north.

PROF. D. S. MARTIN mentioned the occurrence of similar plants in the schists of the neighborhood of Providence, R. I.

PRESIDENT NEWBERRY called attention to the contorted character of the rocks and the consequent imperfect nature of the fossils exhibited. Besides a *Lepidodendron* already noted there are fragments of a *Sigillaria* and of fern stipes. The general character of the deposit is similar to the Carboniferous area of Newport and vicinity, but the material hitherto seen is insufficient for positive identification.

MR. G. F. KUNZ exhibited orthoclase crystals from veins, with zeolites and pyrite, in the diabase of the West Shore Railway tunnel at Weehawken.

MR. B. B. CHAMBERLIN remarked on the occurrence of large feldspar crystals elsewhere in the trap, and of albite in the diabase of Graniteville, Staten Island.

The PRESIDENT exhibited copper instruments of hitherto unnoticed forms, collected near Houghton, Michigan, by MR. RAYMOND.

MR. CHAMBERLIN remarked on copper spear heads, ten inches in length, now in the museum of the Historical Society of Houghton.

MR. JOHN C. BRANNER, of Scranton, Penn., then read the announced paper of the evening on—

COTTON IN BRAZIL; ITS HISTORY, METHODS OF CULTIVATION AND THE INSECTS AFFECTING IT.

MR. CHITTENDEN stated that Columbus found the Indians of Cumana using cotton in the fabrication of coarse cloth.

PROF. MARTIN referred to the finding of cotton in the wrappings of Peruvian mummies.

PRESIDENT NEWBERRY remarked on the uses made of cotton by the Moqui Indians of Arizona.

MR. G. F. KUNZ exhibited a specimen of, and remarked on, a large metallic meteorite, which fell in New Mexico some time since.

May 4th, 1885.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty-five persons present.

The Report of the Council was adopted, which recommended elections as follows:

MR. R. F. PEARSALL and MR. HENRY EDWARDS were elected Resident Members.

MR. HASKELL exhibited and remarked on specimens of white talc from near Gouverneur, St. Lawrence Co., N. Y., and its use in paper weighing. The bed is from six to thirteen feet in thickness, and a shaft has been sunk on it to a depth of ninety feet. He also exhibited specimens of amber colored mica from the same neighborhood.

MR. CHITTENDEN remarked on the very general use of mineral matters in paper manufacture and the difficulty of obtaining non-weighted paper. DR. JULIEN remarked on the association of talc, serpentine and tremolitic minerals.

DR. A. H. ELLIOT then read a paper on

BUILDING STONES USED IN NEW YORK CITY. II.—LIMESTONES.

(Illustrated with specimens and analyses.)

The subject was discussed by DR. JULIEN and the President.

May 11th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty-five persons present.

MR. B. B. CHAMBERLIN exhibited and remarked on certain minerals from New York City. Among these were Fibrous arragonite in veins one-half an inch in width in the crystalline limestone of Morrisania, the only other locality known to him being in the Fourth Avenue tunnel, at Ninety-sixth Street. He had now collected ten varieties of mica from the metamorphic rocks; among them a variety with a golden yellow color in small plates, from the Boulevard. An imperfect crystal of ripidolite two inches in diameter was found on Jerome Avenue. Near the Morrisania arragonite locality he had found a deposit of chloritic earth, and much of the limestone was impregnated with chlorite.

President NEWBERRY called attention to a paper by JAMES E. DE KAY in Annals Lyc. Nat. Hist., i, p. 45, pl. v., 1823, on fossil organisms then supposed to resemble Trilobites, and termed by the writer *Bilobites*. DE KAY, however, seems to have supposed that they were Mollusks, alied to *Cardium*, and SAY thought they resembled the genus *Productus*.

The figures show them to be *Conocardium* a Devonian mollusk. By a strange oversight M. THE MARQUIS DE SAPORTA, in his work on "Organismes Problematiques des Anciennes Mers," includes the fossil Palæozoic Algæ *Rusophycus* and *Cruziana* under the name *Bilobites*, stating that DE KAY's name has priority!

The announced paper of the evening was by MR. JAMES F. KEMP on "The Geology of the Bermuda Islands." In the unavoidable absence of MR. KEMP the paper was not delivered.

MR. F. J. H. MERRILL remarked on the

GEOLOGICAL STRUCTURE AND AGE OF THE DEPOSITS AT GAY HEAD, MASS.

(Illustrated with specimens and sketches.)

He referred the beds, which are greatly contorted and faulted, to the Post Pliocene or Quaternary.

DR. N. L. BRITTON remarked on the Serpentines of the vicinity and exhibited specimens from the different localities. He called attention to the view held by Messrs. WHITNEY and WADSWORTH (Bull. Mus. Comp. Zool., Cambridge (vol. vii., p. 465) that the Staten Island Serpentine was the result of the alteration of an igneous rock, whereas all the Serpentines of the neighborhood are plainly but the alteration of stratified Archæan rocks, mainly limestones and tremolitic schists.

The subject was discussed by the PRESIDENT, who agreed with the speaker.

May 18th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

A large audience assembled in the east lecture room of the Library Building, Columbia College.

The fourth lecture of the Popular Lecture Course was delivered by PROF. DANIEL C. EATON, subject,

HYBRIDS AND HYBRIDISM.

May 25th, 1885.

STATED MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Ten persons present.

MR. W. E. HIDDEN remarked on

HANKSITE, A NEW ANHYDROUS SUPHATO-CARBONATE FROM SAN BERNARDINO COUNTY, CALIFORNIA.

(For description and analyses see ANNALS, vol. iii., pp. 228–241.)

A paper by DR. N. L. BRITTON,

A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS SCLERIA.

was read by title (Published in the ANNALS, vol. iii., pp. 228–237).

PROF. D. S. MARTIN described an interesting case of freezing by the cold of evaporation noticed by him in the summer of 1883. At Richfield Springs, N. Y., the gas used in the New American Hotel is manufactured from a light naphtha. This naphtha contains some water and the circumstance noted was this, viz: that in some barrels of the naphtha lying in the sun a leakage took place through crevices in the barrels, and there the cold produced by the very rapid evaporation of the naphtha froze the water into a snow-white efflorescent line or band. It was a curious and very striking illustration of the old and well-known experiment of freezing water in a hot ladle by previously mixing it with ether, which is so violently evaporated by the heat as to freeze the water to ice.

MR. W. E. HIDDEN exhibited photographs of a meteorite found in Laurens Co., N. C., in 1857, and now first described.

June 1st, 1885.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the chair.

Thirty-six persons present.

The Report of the Council, recommending payment of bills, was adopted.

MR. G. F. KUNZ exhibited a blue beryl from Mt. Anteros, Colo.

MR. W. E. HIDDEN then read the following paper;

MINERALS OF SPECIAL INTEREST AT THE NEW ORLEANS EXHIBITION.

The Academy then adjourned till Oct. 5th, 1885.

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